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# SURGERY, GYNECOLOGY AND OBSTETRICS

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## EXTRADURAL SPINAL TUMORS—PRIMARY SECONDARY, METASTATIC

By CHARLES A. HISHIG MD FACS NEW YORK

### THE GROUPING AND HISTOLOGICAL STRUCTURE OF THE ENCAPSULATED TUMORS OF THE SPINAL CORD AND MEMBRANES

It is useful to group spinal cord tumors into those outside of the dura mater—the extradural—and those inside of that membrane—the intradural—and still further to divide the intradural growths into the extramedullary and the intramedullary.

The technical improvement in the operative procedures for the exposure and removal of extramedullary tumors—in which the dura is first incised without injury to the arachnoid—has made it possible to demonstrate at the operating table that some of these growths lie entirely outside of and others inside of the arachnoid.

Intradural extra arachnoid growths may be attached to the inner surface of the dura or only to a nerve root and those within the arachnoid may be adherent only to that membrane to a spinal nerve root or rarely only to the pia mater. A growth attached to a nerve root but otherwise free within the arachnoid cavity may be a true meningeal tumor with an assumed origin from the expansion of the leptomeninges over the root and one presumably derived from the perineurial connective tissue sheath of a spinal nerve root may be adherent to the dura without any visible connection with any part of the root.

Similar variations may be met with in extradural spinal tumors a growth of meningeal

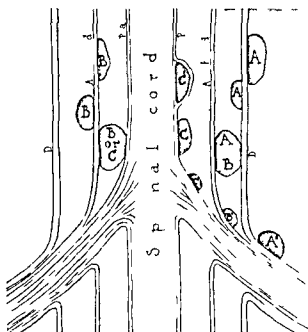
origin may be attached to a nerve root or a tumor derived from the sheath of a nerve root may be grossly adherent only to the dura.

The efforts made by many investigators to classify the encapsulated tumors of the nervous system from the standpoint of their microscopic structure have resulted in a wide variety of conclusions regarding their nature and origin and it is therefore not surprising that there is a diversity of opinion regarding the histological features of tumors of the spinal cord.

Anton in his monograph on 'Ruecken markstumoren und Neurofibromatose' uses the terms endothelioma and neurofibroma or neurinoma for the two most common varieties of spinal tumor. On account of a lack of agreement concerning the pathological nature of the meningeal tumors which were variously classified as endotheliomata or sarcomata Cushing suggested the name meningioma. This term is descriptive of certain intracranial dural growths but if spinal tumors adherent only to the dura were called by the same name the so called neurofibroma which is sometimes attached only to the dura might from its gross appearance be called a meningioma.

Mallory proposed the name arachnoid fibroblastoma for the tumor commonly called endothelioma and perineurial fibroblastoma for the so called neurofibroma. According to Mallory there is no true endothe-

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lum on the inner surface of the dura the inner layer of which is composed of flattened fibroblasts. He proposed the name arachnoid fibroblastoma in order to indicate that the growth originates from and reproduces the general structure of the arachnoid villi.

Mallory studied mainly the cerebral tumors removed by Cushing and in these naturally it was impossible to determine either at the operation or under the microscope the degree of intimacy of relation between the new growth and the arachnoid.

The condition within the vertebral canal are favorable for the elucidation of this question. In some of our spinal meningeal tumors we have found the arachnoid entirely free from the growth so that a neoplasm adherent to the inner surface of the dura could be raised up from the grossly normal arachnoid as soon as the dura had been incised and the cut edge retracted.

In spite of the researches of Harvey and Burr which seemed to show an ectodermal origin of at least part of the meninges the

preponderance of evidence supports the view that the membranes are developed from groups of cells in the perimedullary mesenchyme. It is very probable that the tumors variously called endotheliomata meningiomata or arachnoid fibroblastomata are derived from cells which were normally destined to form part of the arachnoid but which remained with the cell groups which finally differentiated into the cells of the dura mater. The occasional occurrence of both intracranial and spinal *extradural* tumors of the typical endothelioma structure support such a viewpoint (Fig 1).

In addition to the ordinary staining methods Penfield used those of Cajal and Del Rio Hortega. In a study of the spinal tumors removed in our clinic he has recently shown that there are distinct histological differences between the three main types of benign encapsulated tumors of the nervous system—the meningeal fibroblastoma (endothelioma meningioma arachnoid fibroblastoma), the perineurial fibroblastoma derived from a spinal nerve root or peripheral nerve (solitary neurofibroma neurinoma) and the neurofibroma of von Recklinghausen's disease. According to Penfield although the first two varieties are fibroblastic they are easily distinguished from each other microscopically because each retains the morphological characteristics of the specialized connective tissue from which it arises. Only in the last group is nervous tissue to be found.

The terminology used by Penfield—meningeal fibroblastoma perineurial fibroblastoma neurofibroma of von Recklinghausen—I think the best that has been hitherto proposed. The differentiation of the von Recklinghausen tumors from the solitary perineurial fibroblastomata constitutes an important advance in the histological classification of encapsulated tumors of the nervous system. The term meningeal fibroblastoma is a happy one because grossly the tumors of this type may be attached to any of the three membranes (see Fig 1). It is possible that these growths may be derived from dislocated mesenchymal arachnoid cells grouped with either pia or dura mater.



Fig. 2

Fig. 2. Case (N. I. 1196) showing the appearance upon exposure of an extracranial meningioma (cell 3).

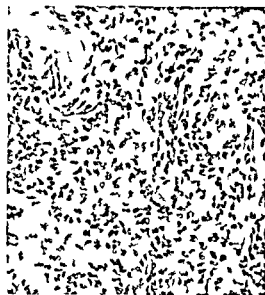


Fig. 3

Fig. 3. Case 17. Photograph and photomicrograph showing tumor and its structure (H and E stain,  $\times 100$ ).

# THE FREQUENCY AND CLINICAL FEATURES OF EXTRADURAL AS COMPARED WITH INTRADURAL TUMORS

Table I includes all of the extradural and intradural tumors exclusive of intramedullary and metastatic extradural growths operated upon in my clinic to September 1927.

TABLE I—EXTRADURAL AND INTRADURAL TUMORS OPERATED UPON TO SEPTEMBER 1927

	Intracranial	Intracranial	Total
Meningeal fibroblastoma (endothelial fibroblastoma)	3	72	75
Perineurial fibroblastoma (neurofibroma neurinoma)	5	37	42
Neurofibroma of von Recklinghausen's disease		5	7
Fibroma	1	3	4
Sarcoma	17	8	25
Chondroma	11	0	1
Lipoma	1	3	4
Angioma	2	1	3
Chordoma	2	0	
Ependymoma	0	1	1
Lymphoma	0	1	1
Tuberculoma	1	0	1
Dermoid	0	1	1
Ganglion neuroma	1	0	1
Neuroblastoma	0	1	1
Total	46	133	179

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Thus excluding intramedullary and metastatic growths 46 or 26 per cent were extra-

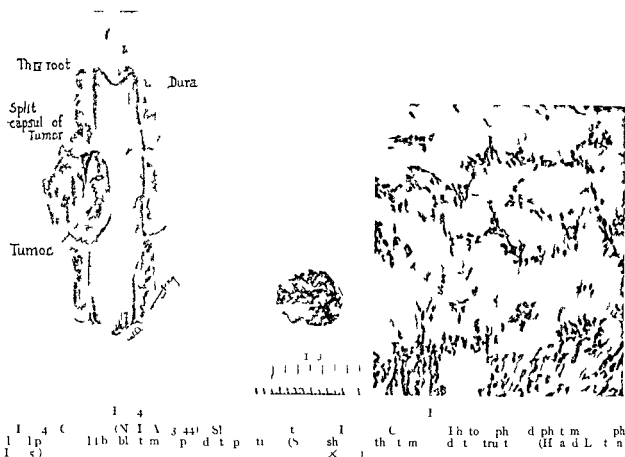
dural and 133 or 74 per cent were intradural. The meningeal and perineurial fibroblastoma formed a large proportion of the tumors inside of the dural sac but they were much less frequent outside of that membrane (8 per cent of intradural and 17 per cent of extradural growths) while the sarcomata and chondromata which formed 61 per cent of the extradural tumors were comparatively rare inside of the dura (6 per cent of intradural extradural growths were classified as sarcomata).

A clearer idea of the relative frequency of the most common extradural and intradural growths can be gained from Table II.

TABLE II—PERCENTAGE OF FREQUENCY OF THE MOST COMMON EXTRADURAL AND INTRADURAL TUMORS IN A SERIES OF 179 CASES (INTRAMEDULLARY AND METASTATIC GROWTHS NOT INCLUDED)

	Intracranial	Intracranial	All
	p	p	p
Meningeal fibroblastoma	7	54	42
Perineurial fibroblastoma	11	28	3
Sarcoma	37	6	14
Chondroma	24	0	6
Neurofibroma (von Recklinghausen)	4	4	4
Fibroma	2	2	
Lipoma	2	2	2





The increase in size of the intradural meningeal and perineurial fibroblastomata which form 8 per cent of the e growths is a slow and gradual one and in most instance the sign of interference with cord function advance slowly. These growths are more infrequent outside of the dura (17 per cent of our series of extradural tumors). On the other hand the sarcomata which are rarely intradural grow more rapidly and either make pressure upon the dura early or more or less suddenly extend into the vertebral canal through intervertebral foramina or by bone destruction. Not only rarely secondary and metastatic extradural growth cause an acute softening of the spinal cord at the affected level through interference with its blood supply.

In this connection mention must be made of another fact which we have found in the study of our extradural tumor. The perineurial fibroblastomata and the neurofibromata of von Recklinghausen disease as well

as the relatively infrequent extradural angiomata usually cause slowly progressive cord disturbances while the symptom due to *extradural meningeal fibroblastomata* progress much more rapidly. In the three cases of our series the interval between the first symptom and marked cord symptoms was 7, 7 and 11 months or an average of 4½ months.

For all of the reason the course of spinal cord symptoms in extradural tumor is often more rapidly progressive. Although in many extradural tumors the signs and symptom of cord involvement progress slowly and in some intradural growth the advance is rapid still all in all a short history must make one suspect that the neoplasm is outside of the dura.

Idiopathic pain as an early symptom does not occur as often in extradural expanding lesions because of the relatively smaller number of instances in which the growth begins in the sheath of or in close apposition to a nerve root. Not so rarely due to the interposition

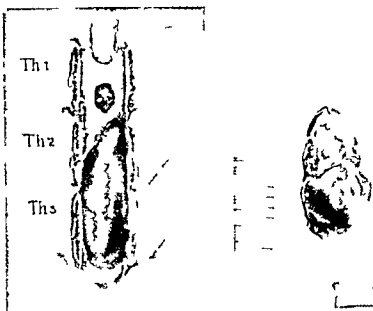


Fig 6

Fig 6 Case 15 (N I 19995) Sh in two extramedullary fibroblastomas exposed at operation (N II)

of the firm dura and of a buffer of cerebrospinal fluid the early spinal cord disturbances have a vague and indefinite character. Sudden exacerbations of signs and symptoms occur relatively often and a flaccid paraplegia occurring within a few days of the onset of weakness of the limbs is seen almost exclusively in malignant extradural disease.

Contralateral motor disturbances, contralateral paresthesias in the lower extremities and the reverse Brown Sequard syndrome (most marked motor disturbances on the opposite side and most advanced sensory diminution on the same side as the tumor) are more often observed in extradural growths.

Changes in the bony structures visible on the X-ray films occur in more than one half of all extradural tumors although in some instances considerable bone destruction is seen at the operation which was not apparent on the X-rays. These bony changes are either an enlargement of the vertebral canal (best seen in lateral stereoscopic views of the spine), a localized defect in one or more vertebrae, a scoliosis at or above the location of the disease, an actual shadow of the new growth, or finally a sinking together of the bodies of several vertebrae. In intradural growths bony changes in the X-rays occur rarely except in



Fig 7

Fig 7 Case 15. Photograph and photomicrograph showing the two tumors and their structure (Th1 and Th2) (X 150)

the so called giant tumors of the conus and cauda equina in which an enlargement of the vertebral canal is usually clearly seen on the X-ray films. Occasionally there is a localized arthritis of the vertebra at the general level of the intradural new growth.

With some exceptions that will be described later on (very small growths such as the ven-



Fig 8 (left) Case 18 (N I 1490) Shows a chondroma of unusual form removed from the ventral aspect of the dura (see Fig 9)

Fig 9 Case 18 Shows the structure of the tumor (Mallory's phosphotungstic acid stain X 110)

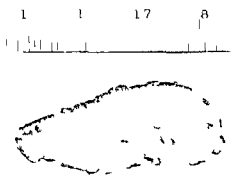
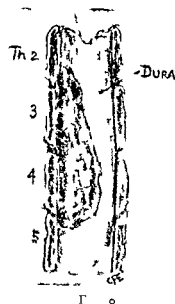


Fig. 1. (M. S. H. 2, 3) Ph. t. g. ph. a. d. (H. 1. E. t. m. X 50—1 th. L. b. M. S. H.)

Fig. 2. (H. 1. E. t. m. X 50—1 th. L. b. M. S. H.)

tral chondromata derived from an intervertebral disc etc.) the manometric studies of the spinal fluid have demonstrated a more or less marked spinal subarachnoid block. The fluid obtained by lumbar puncture was often yellow in color and contained an excess of globulin or total protein although the figures of protein increase were never as high as in intradural cord compression (*vide infra*).

After spinal fluid had been withdrawn by lumbar puncture a distinct and often very marked increase in the subjective and objective signs of cord disturbance was often observed. Oppenheim, Newmark, and others once warned of the danger of increase of symptom after lumbar puncture but they made no statement whether this occurred more often in extradural or in intradural growths. In a paper published in 1922 we called attention to the diagnostic significance of such an increase of symptoms and stated that it is especially frequent in extradural tumors and in some intradural growths adherent to the dura.

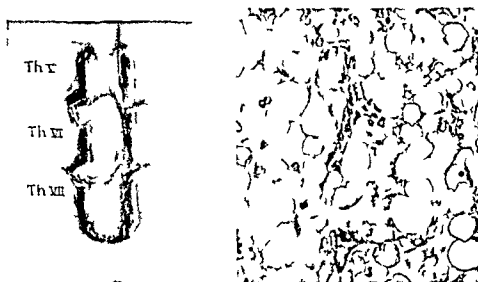
In both extradural and intradural tumors adherent to the dura indefinite level signs not rarely become distinct and motor and sensory disturbances more marked after fluid has been withdrawn from the lumbar subarachnoid space. A careful neurological examination should therefore always be made not only before but also after the puncture.

If the history of the illness is a short one (4 to 8 months) and there are bone changes visible in the X-ray films an increase of signs after the removal of fluid by lumbar puncture usually means that there is an extradural tumor. If on the other hand there is no X-ray evidence of bone destruction and the clinical history one of slow progression the only conclusion that can be drawn from an increase of symptoms after lumbar puncture is that a growth—either extra- or intradural—is adherent to the dura.

#### THE CLASSIFICATION OF EXTRADURAL SPINAL TUMORS. THE SYMPTOMS OF PRIMARY SECONDARY AND METASTATIC GROWTHS

Primary, secondary, and metastatic extradural growths within the cranial cavity are relatively infrequent as compared with tumors of the brain itself or of cranial nerves or membranes and it is rarely difficult to distinguish between the one and the other.

Th. f. t. th. h. y. ll. hoch. m. d. h. l. d. l. m. m. k. t. (M. S. H. 2, 3) Ph. t. g. ph. a. d. (H. 1. E. t. m. X 50—1 th. L. b. M. S. H.)



11, 12 (left) Case 2 (M S H 279934) Showing appearance at operation presented by an extradural lipoma (11, 13)  
11, 13 Case 22 Showing the structure of the tumor which consists of embryonal fat tissue (H and E stain X 40—1st Lab M S H)

The conditions are different in the vertebral canal. Compression of the spinal cord by tumors not derived from cord roots or membranes is of frequent occurrence and it is therefore especially necessary to group spinal growths according to their location and the structures from which they originate. In other words a large number of extradural spinal tumors begin in the bony framework of the spine or in the soft tissues which surround the bone. They may be primarily within the vertebral canal or may only secondarily invade the extradural space. The histological structure of these growths is naturally subject to many variations.

The classification of extradural new growths without adequate differentiation between those that are *primarily* extradural and those that *secondarily* extend into the vertebral canal has led to some confusion. Vertebral tumors are often but not always considered apart but not a few growths that originate from the bony or cartilaginous framework of the spine are both in their location and their mechanical effects *primary* extradural tumors. On the other hand benign and malignant tumors often extend into the vertebral canal at a late period of their growth and they may never affect the dura or the nervous structures within the dural sac.

Most of the tumors that cause cord or root symptoms do so by direct pressure some by

interference with the blood supply and a secondary myelomalacia. In still other cases the interference with cord function is due to a sinking together of the bodies of several vertebrae and not to the direct pressure of the neoplasm.

Aside from the grouping of extradural tumors according to their histological structure a classification of these growths based upon their time relation to the vertebral canal is necessary if the variations in their clinical course are to be understood. From this viewpoint extradural tumors may be divided into (1) *primary* extradural (2) *secondary* extradural (3) *metastatic* extradural. Of the 46 cases in our series of extradural growths (not including the metastatic tumors) 24 or 52 per cent were *primary* and 22 or 48 per cent were *secondary*.

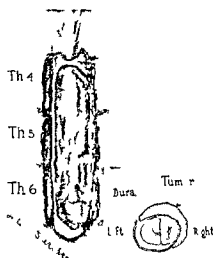
#### 1. Primary extradural spinal tumors

- a. Growths that arise from the dura, nerve roots or epidural fat and blood vessels and are located entirely within the vertebral canal.

The most common forms histologically are

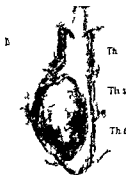
- Meningeal fibroblastoma
- Perineurial fibroblastoma
- Sarcoma
- Chondroma
- Lipoma
- Angioma
- Fibroma

Neurofibroma of von Pecklinghaus disease



I 4

Fi 4 C o (N I 4 66) Sh n th pp cc  
at p r t n f a p m y t a d l m  
Fi 5 Ca 4 (M S H o 88) An c t a d u l  
m i n g a l f i b b l t m a s v j d t p a t n n t the  
s u m l t y t o F 6



I 15

I 6 Ca 3 (N I A 4933) Sho perna l  
f i b b l t m p o d a t p a t i n i n h i h a t v a d f i  
c l t t t h t h o r t t h e g o t h p m d y e  
t d r a l



F 6

b Growth that arise from the walls of the vertebral canal—the ligaments intervertebral cartilage and the bone and lie entirely within the vertebral canal

The most common form re  
Chondroma of an intervertebral disc  
Sarcoma  
Osteoma

## 2 Secondary extradural spinal tumors

Growths from structures outside of the vertebral canal which secondarily invade the extradural space

Sarcoma of the soft tissues of the back or thorax or of the bony spine  
Chondroma of a vertebra  
Chordoma  
Ganglion neuroma  
Hydatid cyst

## 3 Metastatic extradural spinal tumors

Carcinoma—most often from breast, thyroid, prostate or gastro intestinal tract  
Sarcoma and lymphosarcoma  
Hypernephroma  
Myeloma  
Lymphoma of Hodgkin disease

There are inherent possibilities of error in this classification. Some tumors derived from bone or cartilage which would be included in the primary group may have begun within the substance of these tissues before they extended into the vertebral canal and they might therefore actually belong to the secondary growths likewise a tumor classified as sec

ondary may have begun in the vertebral canal before it invaded the extradural tissues and therefore was actually a primary extradural growth. With this reservation the above classification should avoid some of the confusion regarding the symptoms and course of extradural tumors that has occurred in the past.

## I PRIMARY EXTRADURAL TUMORS

a From dura, nerve roots or epidural fat and blood vessels. With the exception of some of the dural sarcomata which are not well encapsulated, most of the growths in this group arise from dura or nerve roots and have a good capsule. In size and in gross appearance they are very like the typical intradural extramedullary growths—to 4 centimeters in length and 1 to 2 centimeters in width and often loosely adherent to the surface of the dura (Figs 3A, 5A, 11A). As in the intradural growths they are most often found on the posterior or lateral aspects of the dural sac. The tumors are usually single meningeal fibroblastomata (Figs 3 and 5) or perineural

W h t h p l f g u d s t h l d f m h b t h  
p h t m p h k f h h g p h h m w  
p p e d h L a b o r y f N c y l g y P b y H p l  
p d t h d i t u f D W l d c P f i l l w h m l m d b d  
f t h c a f l d i e s f m m a u l b y d i f f u l t a n s  
m t h d s

fibroblastomata (Figs 4 and 5) fibromata angiomata or lipomata

In one instance (Figs 6 and 7) there were two distinct perineurial fibroblastomata adherent to the dura but not grossly connected with any nerve root but if more than one tumor is met with one must think rather that the growths are neurofibromata of von Recklinghausen's disease in which multiple encapsulated growths both outside of and within the dural sac are frequent

One chondroma included in this group was well encapsulated and loosely adherent to the dura. The tumor was of bizarre shape it lay on the ventral aspect of the dural sac not connected with bone or intervertebral cartilage and was loosely attached to the dura (Figs 8 and 9). This one chondroma is included in this group because it was entirely different from the ventral chondromata derived from an intervertebral disc and from the secondary extradural chondromata to be described in another part of this paper

In two patients encapsulated tumors loosely attached to the dura had the gross appearance of extradural meningeal fibroblastomata but histologically the growth was made up of a mass of small blood vessels with no microscopic evidence of the type structure of the meningeal fibroblastoma (Figs 10 and 11). Extradural lipomata are rare and there was only one example in our series. In this patient the growth was part of a generalized lipomatosis—an *adenolipomatose symmetrique*—and the microscopic study (Klemperer) demonstrated that the growth consisted of embryonic fat tissue (Figs 12 and 13).

The average length of time that elapsed before there were more or less well marked motor and sensory cord disturbances was between 16 and 17 months but there was considerable variation in this respect between the different varieties of new growth.

In the fibromata perineurial fibroblastomata and the angiomata the average period from first symptom to operation was 27 months in the primary chondromata it was only 13 months and in only 2 of the 7 patients was the history of more than 1 year's duration. The course of the extradural meningeal

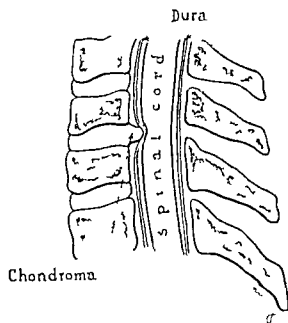


Fig. 12. Shows the usual location of a ventral vertebral disc chondroma.

fibroblastoma in our series was a remarkably rapid one with an average of only 4<sup>1</sup>/<sub>2</sub> months from the beginning of symptoms to the time of marked cord involvement.

In many of these patients the clinical picture was so similar to that of an intradural tumor that the diagnosis extradural tumor could only rarely be made with any degree of certainty. The course of the comparatively infrequent primary dural sarcomata may also be slowly progressive. A more or less prolonged period of pain in the back not characteristically radicular in character followed by rapidly advancing signs of disturbance of cord function are however outstanding clinical features of secondary and metastatic extradural tumors.

In the benign encapsulated growths in case of cord symptoms after withdrawal of fluid by lumbar puncture occurred in almost one half of the patients no matter whether the manometric tests showed a complete or only a partial spinal subarachnoid block. If the records in many of our earlier and some of our later cases were complete the percentage would be a much higher one probably 75 per cent. Anethochromia does not occur so often as in intradural tumors and the increase of globulin or of total protein was never so high as in intradural growths. In

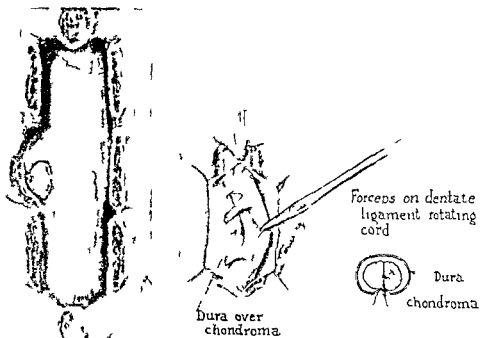


FIG. 13. (left) Case (VI 634) Shows the presence of vertebral d c  
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most of the cases the total protein was 50 to 60 milligrams or only slightly above the normal and the highest protein content was 150 milligrams. In one patient with an extradural fibroma the spinal fluid was normal in all respects.

The primary extradural sarcomata occur in two distinct forms. In one variety the tumor is encapsulated more or less firmly attached to the outer surface of the dura does not become adherent to the wall of the vertebral canal and rarely extends outward through intervertebral foramina. The predominant character of this form of extradural sarcoma is to extend along the surface of the dura and especially to more or less completely surround the dural sac. Not rarely there is a large amount of tumor tissue on the ventral aspect of the dura. The upper and lower limits of these growths can often be exposed by the removal of the arches of 2 or 3 vertebrae and the firm reddish brown tumor can usually be peeled off from the dura (Fig. 14) perhaps with a layer of that membrane. In some instances a growth that from its gross character appears to be a sarcoma is

found on microscopical examination to be a meningeal fibroblastoma (endothelioma). In some of our cases the growths were very cellular and did not contain the typical whorls (Fig. 15).

Some primary extradural sarcomata although well encapsulated extend along the dura for a considerable distance so that their upper and lower limits can not be exposed at the operation and they may as in one case of our series extend from the cervical to the lumbar region (diffuse sarcomatosis of the dura). These extensive growths retain the characteristic that they do not become adherent to the wall of the vertebral canal.

The second variety of primary extradural sarcoma occurs as a well encapsulated tumor which extends beyond the confines of the vertebral canal through intervertebral foramina or by bone destruction. The growth is hour glass in shape the smaller part within and the larger mass outside of the vertebral canal and in many instances it is difficult to determine whether the neoplasm began as a primary extradural growth or whether the

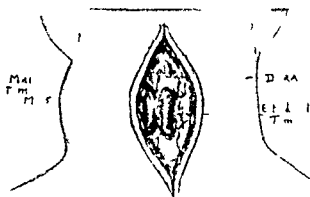


Fig. 10 (left) Case 10 (N. I. A. 5) Shows the tumor at the base of the neck in view of cervical neurofibroma.  
Fig. 21 Case 10 The relation of the extradural extension into the vertebral canal in the same patient as Fig. 10

extradural part was secondary (Fig. 16) Boerner Guleke and Borchardt have called special attention to the dumb bell shaped tumors which begin outside of the dura within the vertebral canal. In several of their cases the primary extradural origin of the growth was proved by the fact of outgrowths through two intervertebral foramina.

The clinical course of this form of extradural sarcoma does not differ from that of the first variety excepting that bone changes are more frequent.

*b Tumors which arise from the vertebral or the intervertebral cartilages and lie entirely within the vertebral canal.* In our series there were 7 instances of chondroma derived from an intervertebral disc.

The intervertebral disc chondromata have been recently studied by Dr Stookey. They are small hard growths no more than 1 to 1<sup>1</sup> centimeters in length which originate from and are firmly fixed to the anterior wall of the vertebral canal probably always from an intervertebral disc (Fig. 17). They have been found only in the cervical region and compress the dura from its ventral aspect either in the midline or more to one or the other side.

In none of our cases was there any bone changes visible on the X ray films.

The clinical history may be a short one—less than 6 months or of 1 to 2 years duration. In one of our patients the prominent symptom was pain referred to the distribu-

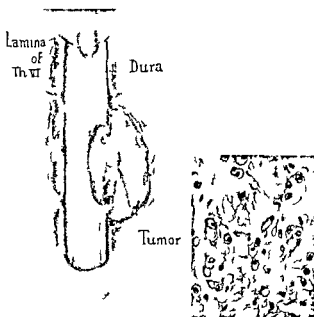
tion of one sensory root and at the operation the tumor was found just underneath the affected nerve root (Fig. 18). In all of the other cases the subjective and objective disturbances pointed to a progressive compression of the cord from its ventral aspect (paresthesias and dysesthesias referred to the lower limbs marked unilateral or bilateral diminution of motor power sensory diminution which involved especially pain and temperature sensibility and was some times of the Brown Sequard type).

The manometric tests showed that there was a complete subarachnoid block in 2 patients and a partial block in 1 while in the others there was no demonstrable interference in the pathways of the spinal fluid substantiated in 1 patient by a lipiodol injection. With one exception the fluid removed by lumbar puncture showed neither a change in color in globulin or protein content or in the number of cells.

In every patient in whom there are the evidences of a localized and slowly advancing involvement of the spinal cord in the cervical region in whom X ray is negative the spinal fluid normal and the manometric tests negative or almost negative the possibility of a ventral intervertebral disc chondroma must be kept in mind.

These ventral chondromata are probably much more common than we have hitherto believed and vague symptoms referable to





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one or more segments of the cervical cord may in the future be shown to be not so rarely due to a very small cartilaginous outgrowth on the ventral aspect of the dura. The tumors are so small in size and in such a location that they can be easily missed unless the exploration is made by an experienced neurosurgeon and they can often be found only after the dura has been incised and the cord rotated and drawn over to one side by traction on the divided slip of the dentate ligament. The small prominence of the dura near the midline can sometimes be felt with the exploring probe after the dura has been opened and can always be seen as soon as the cord has been drawn to one side (Fig 19).

#### SECONDARY EXTRADURAL TUMORS

The growths that begin outside of the vertebral canal and secondarily extend into it—rarely through intervertebral foramina but more often by bone destruction—are either clinically and histologically malignant or benign. These growths may originate from any of the tissues around or at some distance from the vertebral canal from the periosteum or from the bone itself from ligaments

muscles or their fascial coverings from spinal sympathetic ganglia or from nerve sheath. Growths in the posterior mediastinum or in the thorax (ganglion neuroma sarcoma or endothelioma of the pleura hydatid cysts) may extend into the vertebral canal and compress the spinal cord through the dura. We have seen 5 instances in which progressive cord disturbances were due to the extension into the vertebral canal of a large intrathoracic growth visible on the X-ray films. Two of the patients were operated upon and the nature of the growth verified—one was a sarcoma and the other a ganglion neuroma.

The variety of tumor described by Flatau and Sawicki under the name of cervical neurofibroma begins from nerve sheaths outside of the vertebral canal and invades both the deep tissues of the neck and the spinal extradural space. In these patients there is a palpable or visible mass at the root of the neck connected with a smaller mass outside of the dura (Figs 20 21). The malignant chordoma which originates from the remains of an embryonic endodermal structure the notochord usually begins in the body of a vertebra or within an intervertebral disc and secondarily extends into the vertebral canal.

In some instances secondary malignant growths never invade the vertebral canal and therefore do not make any pressure upon the dura and in these patients the spinal cord symptoms are due either to interference with the vascular supply of the cord or to the sinking together of the bodies of one or more vertebrae with angulation or compression of the cord segments at the level of the disease. This occurs however more often with metastatic than with secondary new growths.

The tumors that have extended into the vertebral canal from the outside are usually more or less hour glass or dumb bell in shape—a larger mass outside being connected with a smaller part of the growth on the outer surface of the dura (Figs 22 and 23). In some of the secondary sarcomata and in the chordoma the growth is primarily located in a vertebral body and its extension into the vertebral canal lies in front of the dural sac. More often however the extradural part of the tumor lies on the lateral aspect of the



Fig. 24

Fig. 25

Fig. 24 Case 43 (N 1 A 9530) Anteroposterior view at the operation (Fig. 25)

Fig. 25 Case 43 The true nature of the tumor shown in Fig. 24 (A X 100 B X 310)

dural sac and extends both on the posterior and the anterior surfaces of the dura.

Some of these secondary growths are well encapsulated and the mass outside of the vertebral canal lies in a bone cavity with smooth walls but more often the part within the vertebral canal has a distinct capsule while the primary part of the growth is not well limited by a membrane.

In about 73 per cent of the secondary extradural tumors the development of spinal cord disturbances is a gradual one and from 1 to 3 years elapse before the cord disturbances are well marked. If it were not for the X-ray findings of more or less marked bone destruction the differentiation of these from primary extradural and intradural tumors would be difficult. In the remaining 27 per cent of our cases pain in the back lasting for a shorter or longer period was followed by an advance of spinal cord symptoms more rapid than is seen in intradural growths.

In 17 of the 23 patients with secondary extradural tumors the spinal symptoms were of less than 1 year's and in 10 of these of 6 or less months' duration.

If the patient is seen during the period when the tumor is still outside of the vertebral canal and when he is suffering only from pain in the region of his disease there may be no bone changes visible on the X-ray films and

the manometric tests of the spinal fluid pressure may be entirely normal. On the other hand with negative spinal fluid findings the X-ray evidence of bone destruction may point to the nature of the disease.

The more acute development and the more rapid advance of the signs of spinal cord involvement in most of the secondary sarcomata is easily understood when one takes into account the more active growth of the tumor and its sudden extension into the vertebral canal.

In 83 per cent of the secondary sarcomata the interval between the first symptom and the operation was less than 1 year—on the average between 4 and 7 months.

That a slowly growing tumor such as the chondroma will cause slowly progressive symptoms is to be expected but it is surprising that the course of the two malignant chondromata in our series was a comparatively slow one. In the 2 cases operated upon by the writer the interval between the first symptom and the operation was 10 months in 1 and 12 months in the other patient—a duration no shorter than that seen in many benign intradural and extradural growths. One of our patients with the growth in the mid thoracic region (Figs. 24 and 25) had a slowly advancing spastic paraplegia in the second case the growth lay in front of the

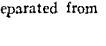
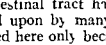
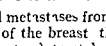
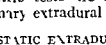
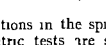
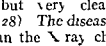
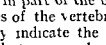
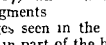
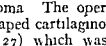
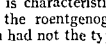
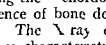
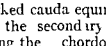
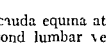
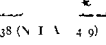
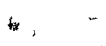


Fig. 38. Lateral view of the lumbar vertebrae showing the roots of the cauda equina at the level of the first and second lumbar vertebrae and had caused a marked cauda equina syndrome.

roots of the cauda equina at the level of the first and second lumbar vertebrae and had caused a marked cauda equina syndrome.

In all of the secondary extradural tumors excepting the chondromata there was distinct evidence of bone destruction in the X-ray films. The X-ray evidence of the chondromata is characteristic (Fig. 6) but in one case the roentgenogram outlined a growth which had not the typical appearance of a chondroma. The operation exposed a dumb bell shaped cartilaginous growth (Figs. 22, 23, and 27) which was removed completely in fragments.

The changes seen in the X-ray are more often defects in part of the bodies, arches or lateral masses of the vertebrae. The defects may not only indicate the amount of bone destruction but very clearly outline the growth (Fig. 28). The disease is usually more extensive than the X-ray changes would indicate.

The alterations in the spinal fluid and in the manometric tests are similar to those found in primary extradural growths.

### 3. METASTATIC EXTRADURAL TUMORS

Extradural metastases from primary malignant disease of the breast, thyroid, prostate or gastro intestinal tract have been studied and reported upon by many writers. They are considered here only because they should be strictly separated from other extradural

growths—a fact which has not always been done in papers on extradural tumors.

The metastasis is most often located in or on the lateral aspect of the bodies of the vertebrae and results in more or less extensive bone destruction visible on the X-ray films.

A period of pain in the back usually made worse by the slightest movement precedes the appearance of disturbances of cord function. Although a slowly progressive spastic paraplegia may occur a rapid progress with complete flaccid paraplegia within a few days is more frequent. The cord symptoms may be due to the rapidly increasing pressure on the dura of the new growth but in many instances the amount of tumor tissue within the vertebral canal is small and the cord symptoms are due to a sudden myelomalacia from profound disturbance of the blood supply or to the sudden collapse of the bodies of one or more vertebrae.

The spinal metastasis may occur many years after the primary growth has been removed. This happened in one of our patients with a metastatic melanosis in whom an eye had been removed 14 years before for a primary tumor of the choroid.

Metastatic tumors may cause only severe root symptoms but more often the disturbances of cord function are well marked. Motor disturbances below the level of the lesion may be profound at a period when there is no or only very slight sensory loss. The symptoms of a complete transverse lesion of the cord are however very frequent.

Although myeloma is really a part of a multiple disease as is extradural lymphoma in Hodgkin's disease and metastatic lymphosarcoma they may be included in the group of metastatic tumors. We have seen one example of each of these tumors. Whenever there is X-ray evidence of bone destruction without a clear history of a primary malignant disease in some other part of the body the urine should be examined for Bence Jones albumin in order to exclude myeloma.

### THE SURGICAL TREATMENT OF EXTRADURAL TUMORS

The technique of the exposure of primary localized extradural tumors unless they have



FIG. 27. Case 45 (N I 13768) Unusual X-ray appearance of a secondary extradural chondroma

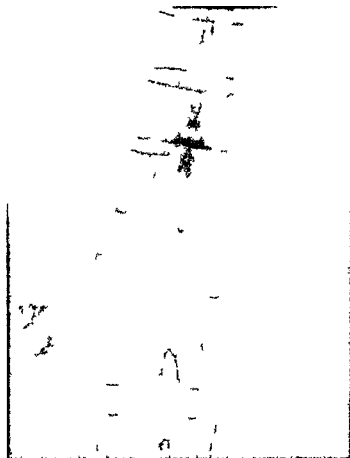


FIG. 28. Case 46 (N I 130418) An X-ray of a secondary extradural tumor which showed the exact size and shape of the growth

extended beyond the confines of the vertebral canal does not differ essentially from that for intradural growths with the exception that the dural sac must often not be opened.

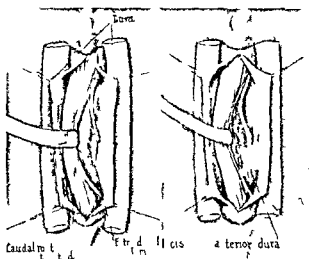
The approach to the ventral vertebral disc chondromata has to be made in most instances transdurally. The transdural approach was described by the writer many years ago because of the difficulties in the recognition and the exposure and removal of these small midline growths by the extradural route. The dura is exposed and incised and the cord is rotated and drawn to one side by traction on a divided slip of the dentate ligament. The bulging dura over the ventrally located growth is then incised and the chondroma which is firmly fixed to the anterior wall of the vertebral canal is removed in layers with a sharp curette. When all of the cartilaginous mass has been removed by this fragmentary excision the dura will fall into

the tumor bed and suture of the incision in the ventral dura is unnecessary.

During the manipulations the greatest care must be taken that the cord is not traumatized and as it is always in plain view this can be accomplished without special difficulty.

This transdural procedure (Figs 19-9-30) may also be useful for the exposure and removal of other small ventral chondromata not derived from an intervertebral disc and of small chordomata.

The removal of extradural tumors which surround more or less of the circumference of the dural sac is often unsatisfactory because the ventral part of the growth may be so extensive that only an incomplete fragmentary removal is possible. Not so rarely there is considerable disturbing bleeding from the veins on the posterior surfaces of the bodies of the vertebrae which requires frequent packing with cotton balls soaked with hot saline solution or with adrenalin. In order to obtain a good exposure the laminae on one side



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must be removed well out to the transverse processes

After the part of the growth that lies on the posterior and lateral aspects of the dura has been excised it may be possible to remove in one piece the extension of the growth on the ventral aspect. More often however only an incomplete fragmentary removal is possible. At any time during the manipulations the operator may find that the growth extends into the body of a vertebra that he is actually dealing with a secondary extradural tumor.

If the longitudinal extent of the neoplasm is so great that its limits can not be exposed by the removal of 3 or 4 vertebral arches the growth is generally surgically irremovable. Little will be accomplished by the excision of the part of the growth that has been exposed and the operation must be concluded with the hope that the patient will derive benefit from the decompressive effect of the laminectomy and from later X-ray treatment.

The complete removal of the secondary extradural tumor is in the main very unsatisfactory. The chondromata can usually be entirely removed together with their capsule although considerable bone and sometimes pieces of several ribs have to be taken away before the new growth can be satis-

factorily exposed and removed *in toto*. An incision at right angles to the longitudinal one is often necessary.

The histologically malignant but well encapsulated growths mostly *fibrosarcomata* can often be completely extirpated from the smooth walled extradural bone cavity in which they lie. At any time during the operation however the operator may find that the growth is infiltrating the muscles so that its complete eradication is impossible. In a number of our patients the tumor removal was complete for the patients have remained well for many years.

In all cases in which there has been considerable bone destruction visible on the X-rays the removal of bone should be as sparing as possible commensurate with an adequate exposure of the growth. Sometimes especially in the cervical region it is advisable to do only a unilateral laminectomy as recommended by Dr A. S. Taylor.

#### PROGNOSIS AND RESULTS

The impression is widespread that the prognosis in extradural tumors is a very poor one that few patients improve after surgical interference and that only exceptionally is a radical cure effected. This impression voiced in many textbooks is an erroneous one and

TABLE III—RESULTS IN THIRTY FOUR CASES

	P m ry	re l ry T	I
D d th			5
D i tl			3
D d thu 4			
I n m y tha 3			4
I n m tha 4		4	7
Unkn	6	3	9
		3	5
			34

If we exclude 1 patient who died from an accident about 1 year after the operation 9 patients are still living and the present condition has been ascertained. Of these there are well or almost well 14, unable to work 3, recurrences 2, a total of 19 cases.

Of the patients with benign tumors there are 3 alive 1 to 2 years, 2 alive more than 2 years after the operation.

Of the sarcomata there are of those who died within 1 year 3, within 2 years 2, within 3 years 1. There are living 1 to 2 years 4, living 3 to 4 years or more 1. In 4 the outcome is unknown and in 2 there was a recurrence.

has been due to the inclusion in one group of not only the primary but also the secondary and often the metastatic growths.

Spinal metastases are from their nature practically always irremovable and as in all metastatic growths should only exceptionally be attacked surgically. If metastatic growths are excluded almost 50 per cent of extradural tumors are benign in nature and technically removable and therefore in at least one half of patients with extradural growth complete eradication of the disease is possible. In addition some of the primary and secondary encapsulated sarcomata can be completely removed.

The end results in the 46 patients of our series can be seen in Table IV and V.

The dangers of the operation in patients with extradural neoplasms are not much greater than that of laminectomy for intradural tumors or for other disease. In our 46 patients or 7 per cent death was due directly to the operative procedure. One patient operated upon many years ago, a child of 5 years with a secondary ganglion neuroma died from shock after the removal of a large encapsulated growth. The second fatality was in a case of ventral chondroma. The patient's wound was healed in 14 days, he had improved very much 3 weeks after the operation when she died suddenly from a pulmonary embolism. The third patient unfortunately succumbed to a wound infection 3 months after the operation.

Table III shows the results in 34 patients, the 3 operative fatalities and 9 cases in which operation was done less than 1 year ago having been excluded.

#### SUMMARY

1. Exclusive of intramedullary tumors and of metastatic extradural and intradural growths about one fourth of all spinal tumors are extradural.

The meningeal and perineurial fibroblastomata constitute 17 per cent of the extradural and 8 per cent of the intradural tumors, the sarcomata and chondromata 61 per cent of extradural and 6 per cent of intradural growths.

2. In general the clinical course of extradural tumors is more rapid, sudden exacerbations

of symptoms not unusual, exaggeration of symptoms and signs after withdrawal of fluid by lumbar puncture very frequent. The early symptoms are often vague in character, root pain infrequent, contralateral motor disturbance and contralateral parasthesias and the reverse Brown Sequard syndrome often observed. The increase of globulin or total protein rarely if ever is marked as in intradural tumors and in many of the vertebral disc chondromata there is no evidence of subarachnoid block by the manometric test.

3. Extradural tumors should be divided into primary, secondary and metastatic. In 46 cases of the metastatic growths 5 per cent were primary and 45 per cent were secondary.

4. Many of the primary extradural growths are benign and encapsulated and completely removable. The meningeal and perineurial fibroblastomata, the fibromata, angioma and chondromata are usually single. The primary extradural chondroma occurs in two forms. In the one the growth lies in the extradural space on the ventral or dorsal aspect of the vertebral arch, in the other the growth is derived from and firmly fixed to an intervertebral disc.

The primary extradural sarcomata occur in two forms. Either the growths are derived from the dura and have no tendency to become adherent to or involve the walls of the vertebral canal or they begin within the canal and erode the bone and grow outwards forming hour glass or dumb bell shaped tumors.

5. The secondary tumors grow into the vertebral canal either through intervertebral foramina or by bone erosion. They arise from the vertebral or paravertebral soft tissues and may be extensions of growths in the thorax or deep tissues of the neck or back. The spinal cord symptoms are due either to the pressure of the extradural part of the growth or to interference with the blood supply of part of the cord and the symptoms are excepting in the chondromata more acute in their onset and more rapidly progressive. The chondromata are true secondary extradural tumors although their clinical course was as slow as that of many benign extradural and intradural tumors.







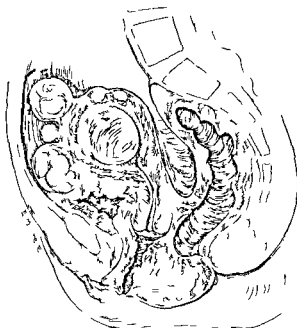


Illustration of a tumor in the uterus, showing the tumor displacing the fetus and placenta.

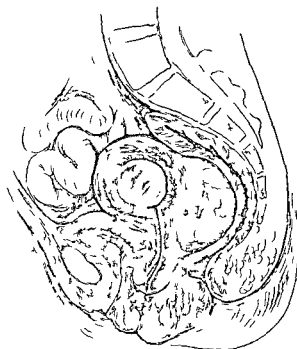


Illustration of a tumor in the uterus, showing the tumor displacing the fetus and placenta.

more and more extruded into the uterine cavity. This necessarily produces a pressure atrophy in the overlying endometrium and a hypertrophy largely the result of the edema in the contiguous uterine lining. Such a mucosa offers a poor surface for embedding—and when embedding does occur on the atrophic surface placental accretion is not unlikely to follow. Furthermore, the location of the tumor as it grows displaces the fetus and determines its position within the uterus. Oblique positions of the fetus or breech presentations in the mid and final trimesters are not infrequent while the occurrence of placental previa is relatively more common. Low implantation is found as a complication in myomatous uterus. This is probably due to the difficulty which the ovum has in finding a suitable place to embed because of the endometrial edema associated with these growths.

Tumor in the lower segment of the uterus or cervix of any considerable size have a clinical significance for they may not only interfere with conception by changing the position of the external os and its relation to the seminal pool or in changing the character

of the uterine secretion but may later become an important factor in the conduct and management of labor. Fortunately, however, after impregnation has taken place they do not in any way affect the development of the ovum except as the fetus grows they tend to produce malpositions owing to the fact that the head cannot fill the lower segment but at labor they present a mechanical factor which may block delivery or interfere with the local drainage in the puerperium. Subperitoneal tumors produce little effect on the presentation or posture of the child unless they are located in the pelvis and many times the labor associated with tumor located in the upper segment is easy and uncomplicated—but because of their rapid growth they may cause extreme abdominal enlargement and pressure embarrassment to the heart and lung and interfere with contiguous visceral functions.

All observers agree that abnormal positions are relatively common complication of pregnancy. When the pregnancy is complicated by abnormal malpresentations not only predispose to early rupture of the membranes which is often followed by premature labor

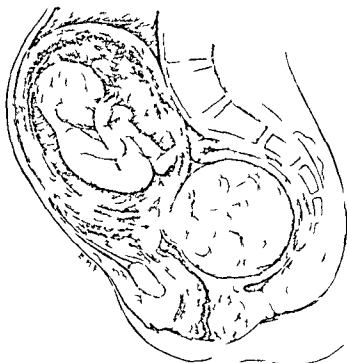


Fig. 3. Increased myoma of lower segment posterior wall making intravaginal delivery impossible

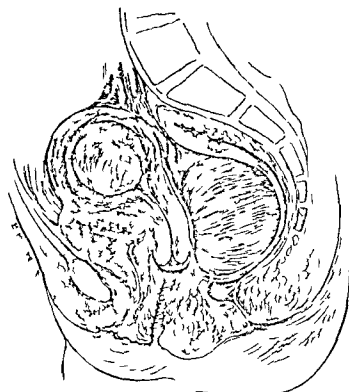


Fig. 4. Large pedunculated subserous tumor requiring cesarean delivery by myomectomy

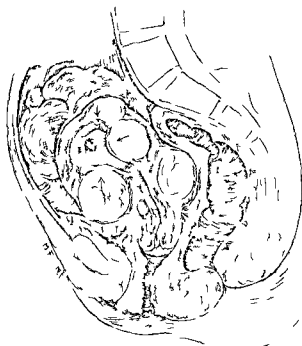
or dry labor but cause uterine inertia and mechanical dystocia. Lanch in a review of this subject by a study of his material at the University of California found incidence of cephalic presentation in 50 per cent breech in 2 per cent transverse in 18 per cent. This means that labor must be more complicated as even a cursory examination of Lichson's excellent table will show. He reviewed the histories of 50,000 labors at the Sloan Hospital for Women and from these he collected 250 cases in which the fibroid tumor was of such a size as to have clinical consideration in the course of pregnancy or labor and then compared the obstetric incidents and abnormalities occurring in this series with those occurring in 8,300 consecutive unselected cases.

These statistics are in line with the personal experience of the writer and should direct the attention of obstetricians to the necessity of correcting the statement so commonly made in textbooks, i. e. although the association of fibromyomata and pregnancy is a relatively frequent one disturbance by them of the normal course of pregnancy and labor is unusual. Certainly we cannot subscribe to

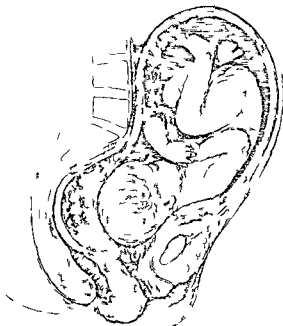
such a statement for any condition which increases the average incidence of abortion or dry labor operative interference postpartum hemorrhage and fetal and maternal mortality from 3 to 6 times the average deserves a more careful clinical consideration. Furthermore, while fibroids have these unfortunate effects on pregnancy pregnancy likewise has an important influence on fibroids for a relatively large percentage undergo some degeneration resulting from circulatory stasis.

Sneed states that 13 per cent of fibroids undergo some form of degeneration during pregnancy. The increased blood supply which is concomitant produces such circulatory changes in the tumor as hypertrophy hyperplasia and increased vascularity therefore all fibroids grow more rapidly under the influence of pregnancy. These tumors become more prominent or flatten out or they may alter their shape and position due to change in location and axis.

During gestation and the puerperium the tumor may undergo necrobiosis or red degeneration edema or necrosis. Red degeneration is a partial death of the tissues within the tumor with hemorrhage into the growth (a



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partial or optic necrosis but is usually surrounded with sufficient healthy tissue to recover. In this form of degenerative change the red blood cells are hemolyzed and the blood pigment unites with necrotic cells. This complication is more common in interstitial growths since in these there is lessening of the blood supply owing to the intermittent contractions of the uterine muscle which is constantly attempting to evolve the growth in the direction of least resistance. These contractions more or less stretch the tumor from its surrounding capsule and leave it in a place in which the blood supply may be inadequate.

Red degeneration occurring during pregnancy presents a typical symptom complex. There is sudden pain referred to the region of the tumor. This is usually followed by the appearance of a bloody vaginal discharge, mild or mount bright in color, an elevation in pulse and temperature, a moderate leucocytosis and a drop in the sedimentation time. Abdominal palpation shows a sudden increase in the tension and tenderness over the tumor mass—the tumor itself increases in size.

Red degeneration is most common during pregnancy, especially in the mid trimester

while adenomyosis and necrosis with or without infection of the tumor are conditions which may be looked for during the puerperium. A degenerated uterine fibroid may be sterile when it will cause few if any symptoms or it may become adherent to the intestine be infected and suppurate and simulate the picture of an acute abdomen with its abdominal pain, tension, distention, temperature, nausea, vomiting and leucocytosis.

The submucous or interstitial tumor may be partly or completely extruded into the cavity of the uterus during the puerperium. As a result of contraction and retraction this may lead to infection of the necrotic mass and produce a puerperal infection with foul lochia and endanger the woman's life from sepsis and continued hemorrhage. Myomata may make pregnancy pathologic by their influence on the symptoms of gestation. For instance pain is often constant, uterine contractions are not only increased but are made more painful or because of the situation of the myoma the uterus may be displaced and packed into the pelvis and occasion a train of pressure symptoms in the bladder, the rectum and in the pelvic veins and nerve extending down the

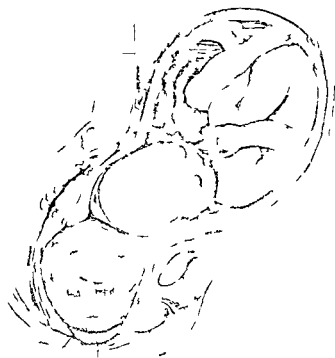
thighs and legs. Furthermore anomalous bleeding is not exceptional and when the tumor is large and rapidly growing, symptoms of abdominal distention with digestive, cardiac and pulmonary embarrassment may obtain.

Fibroids may have a marked influence on labor as there is usually a preponderance of abnormal presentations in pregnancy complicated by these growths. Thus we have predisposed to early rupture of the membrane, uterine inertia, prolonged labor, a high operative incidence, postpartum hemorrhage and an increased mortality to both mother and child. But this again is dependent not on the presence of the tumor but upon its location, size or the number of tumor and their relation to the contracting or dilating zone in the uterus.

Subserous tumors usually do not interfere with parturition unless they encroach upon the lower segment or are subvesical, intraligamentous or become twisted, adherent or impacted in the cul de sac. Impacted myomata are often so placed that uterine contractions cannot lift the tumor out of the pelvis. On the other hand, tumors which during pregnancy seem impossible may be lifted out of the pelvis by uterine contraction and allow spontaneous labor to take place.

Growths that are firmly impacted in the pelvis, displacing, distorting, blocking the cervical os may prevent any form of intra-vaginal delivery and when the constriction is unrecognized cause rupture of the uterus. Intra-vaginal delivery through a blocked pelvis always has had a high operative mortality for the mother. Pierson reports 30 pelvic tumors in 101 cases in which the fibroid was of sufficient size and in locations to cause anxiety to the attendant. Crigin and Ryder found 11 in 98 while we had 6 in 60. The respective operative incidence in these three series was 81, 75, and 66 per cent.

Multiple myomata in the body of the uterus have a direct influence on the character and force of the uterine contractions. We have observed that women in the fourth decade of life who are subject to multiple uterine myomata frequently exhibit instances of primary inertia. This uterine inertia not only mani-



fact it elicits during the first and second stages of labor but continues into the third and becomes an important factor in the causation of postpartum hemorrhage. In Pierson's series hemorrhage occurred in 55 per cent in our series 5 per cent.

The first stage of labor is usually delayed and prolonged, the contractions are irregular and ineffective though they are often more painful for much of the muscular area has been replaced by tumor muscle and if the tumor is in the lower segment of the uterus and prevents a normal presentation with its bill valve action, early rupture of the membranes is the rule and will be found recorded in from 45 to 60 per cent of the cases. This of course is an added factor in retarding the first stage. Likewise with the high incidence of malpositions and early rupture of the membranes it naturally follows that prolapse of the cord is more common owing to the fact that the presenting part fails to fill the dilating lower segment. However should the presenting part come into the pelvis and the tumor be displaced the second stage is not necessarily prolonged though it may be more painful. It is in the third stage in which fibroids often

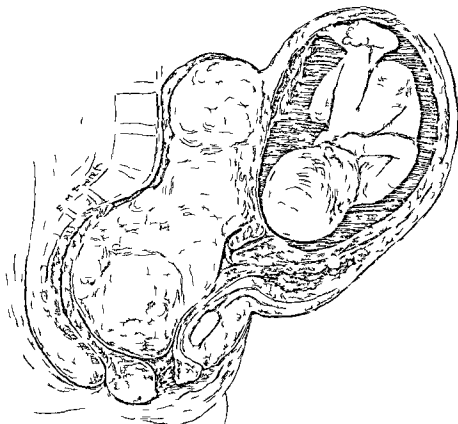


Fig. 81. Illustration of the pelvis showing the uterus and ovaries.

manifest their most serious influence. This stage is abnormal in about 30 per cent of the cases, and this abnormality is manifested first by interference with the placental separation and expulsion, second by postpartum hemorrhage, third by the occurrence of retained or adherent placenta and faulty drainage. All of these complications must be thought of in dealing with this phase of labor.

As a matter of clinical fact, while fibroids may produce all of the aforementioned complications, it is interesting to note that in large series of deliveries relatively few actually require radical surgical intervention. In the Glasgow Maternity, in 15,000 deliveries, only 4 required abdominal section for dystocia, which was directly attributable to the presence of fibroid. At the Clinic Baudelocque in Paris, out of 14,000 deliveries, myomata of sufficient size to be considered of significance in the conduct of labor were found in 84, yet 66 of the cases went to term and had spontaneous deliveries. In Crigén's study of 6,000 cases at

the Sloan Maternity, there were 84 which were complicated by noticeable myomata, but only 11 had pelvic tumors, 9 of which required abdominal section or destructive operations for delivery. In Pierson's recent review of 30,000 cases, there were 191 patients in whom the fibroids were of sufficient clinical importance to require painstaking observation. In this number there were 30 pelvic fibroids

of which required some form of operative intervention to terminate the labor. In my personal series of 7,000 cases, there were 60 in which the position and size of the fibroid gave us anxiety during pregnancy and labor, yet there were but 6 tumors which required removal during pregnancy, and 4 which demanded section during labor to accomplish delivery. One pedunculate tumor of cervical origin was pushed out of the vulva in advance of the presenting part, enucleated by vaginal myomectomy, and spontaneous delivery followed. Hence, it will be seen that nature and retraction of the lower segment of the uterus

during labor are capable in most instances of taking care of the mechanical obstruction.

From the foregoing discussion it is shown that there is an incompatibility between pregnancy and fibroids. This is demonstrated by (1) the frequency of sterility (2) the tendency to abortion and premature labor (3) the stormy experience which some of the patients have in pregnancy and labor and (4) the degenerative changes which occur in these tumors in the puerperium.

#### TREATMENT

The question of the management of fibroid tumors in pregnancy resolves itself into determining (1) whether the life of the patient is endangered by allowing the growth to remain and (2) what effect its removal will have upon the continuation of pregnancy. Our experience shows that women with myomata of the uterus go through pregnancy and often repeated pregnancies with but little difficulty. Tumors that are apparently impacted in the pelvis are frequently lifted out spontaneously either in the course of pregnancy or labor. Therefore the necessity of emptying the uterus by therapeutic abortion when myomata complicate pregnancy very rarely occurs and hysterectomy with the non-viable child *in situ* is one of the rare necessities in surgery. In the interest of the child interference should be delayed as long as possible. The policy should be intelligent expectant expectancy but we should always be ready to act. Therapeutic abortion has no place and is unsafe and unnecessary for not infrequently this is the only pregnancy which this woman may have and interference may damage the tumor tissues to such a degree that convalescence may be protracted and disturbed for the drainage in a fibroid uterus is poor and perforation of the tumor capsule may be the origin of infection. On the other hand spontaneous abortion apparently seems to obviate these dangers. The majority of cases will not require surgical interference unless the tumor by its location or degeneration seriously disturbs changes or endangers the health of the patient.

It has been our practice to delay any operation until after the viability of the child and

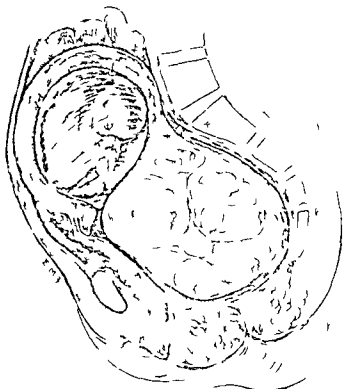


Fig. 3. Impact tumor of the uterus. Treatment by hysterectomy.

try to prevent abortion by instruction is to marital relations rest at the expected menstrual period with the daily employment of the knee chest posture for by the use of this posture the tumor mass and uterus does not become impacted in the pelvis and the pelvic engorgement is relieved.

When the tumor is found in the pelvis in the early months of pregnancy we try to displace it with the patient in the knee chest posture. When this fails we continue the use of the knee chest posture preceded by a minute or two of the mule kick three times a day and wait to see what nature will do. The tumor is frequently carried up and out of the pelvis by the growth of the uterus or during the first stage of labor by the retraction of the lower segment. Only when the tumor has become (1) incarcerated and (2) when a pedunculated tumor becomes twisted or a (3) subserous growth enlarges so rapidly that it embarrasses the heart or respiration or the development of the pregnancy is any operation called for during the progress of the gestation.

Several experiences with operation for red degeneration has taught us that it is safer to allow the acute symptoms to subside and the



may or may not increase in size but conception does not occur. On the other hand the disappointment is all the greater when such a patient after years of sterility finally conceives and aborts early in spite of the greatest care to continue the pregnancy.

When pregnancy goes to term or near term in the fibroid uterus one need not be apprehensive except in rare cases in which the fibroid nodule is cervical or at least so low down it will not rise out of the pelvis as pregnancy advances. A pregnant uterus disturbed by many fibroid growths may and usually does not give rise to trouble at the delivery while the cervical nodule by distorting the birth canal may make the labor extremely difficult. I recall a recent case seen in consultation in which the fetus bulged at the sixth month. The body of the fetus was expelled through the partially dilated cervix the head being left above the nodule. All effort to remove the fetal head from below were unavailing and necessitated a hysterectomy in a puerperal. Fortunately the patient survived after a stormy convalescence but there might have been a sifter story. Looking back over such a history one would have performed the hysterectomy early if it was

the diagnosis of fetal death was established. However on the whole more women and babies will be preserved by conservative treatment.

The danger of postpartum hemorrhage in full term labor in the presence of uterine fibroid is real. I have known of a number of instances in which the labor was perfectly normal yet the woman died or almost died from imperfect uterine contraction. Uterine relaxation may occur even after the expulsion of the placenta and extra precautions should be taken to guard such a patient from postpartum hemorrhage. A number of years ago I had a good opportunity to observe the action or rather non action of a fibroid uterus in which a cesarean was performed for another indication. On the morning of operation to secure efficient uterine contraction occur after the uterus emptied by cesarean that it is humiliating to say the least to be unable to cause the empty uterus to contract with the organ within one's hand. But such was the case. All method failed and I was compelled to remove the uterus to save the woman's life. It demonstrates how helpless we might be in certain cases when the manipulations are from below.



# CONCERNING THE PREVALENT DENIAL OF FUNCTIONS LONG ATTRIBUTED TO THE GALL BLADDER<sup>1</sup>

By EDWARD A. BOYDEN, M. PH. D. CHICAGO  
A. I. F. A. my U. ty III

TWO radical conceptions of the gall bladder which have received considerable emphasis in recent years have had to do with negation of function: first the denial that the gall bladder plays any significant role in digestion (1)—some authors even going so far as to assert that no bile which enters the gall bladder ever leaves it by way of the cystic duct (34, 35); and second the assertion that the gall bladder is a passive organ and that insofar as bile leaves the reservoir it is expelled by extrinsic agencies (or the elastic recoil of enclosing walls) and not by the contractile force of the gall bladder musculature itself (36, 38, 39).

The first of the two views is no longer tenable and the second is fast succumbing to assault. But unfortunately these two negations have become so prevalent in recent years as to have occasioned widespread disbelief in the utility of the gall bladder and this growing skepticism has resulted in the increasing resort clinically to unwarranted cholecystectomy so that it is no longer uncommon to find reputable surgeons removing normal gall bladders with normal appendices when operating for hysterectomy or even in the course of exploratory laparotomies. As will be pointed out later the result of this procedure (in addition to disturbances of the biliary duct system which it creates) is to deprive the patient of that considerable supply of concentrated bile which regularly initiates the digestion of meat and of continuing foods at the beginning of every meal.

## CENTRAL OBJECTIONS TO THE THEORY OF A BILE RESERVOIR

Superficially viewed many facts have seemed to support the denial of active function. For instance it is generally agreed among surgeons that no one ever sees the

human gall bladder contract during an operation. But the reasons for this are sufficiently obvious. First there is no sustained stimulus for contraction; the stomach and duodenum being usually empty of food. Second it has been shown that mechanical manipulation, chilling and deep ether anesthesia inhibit rhythmic contractions of the gall bladder (35). If however the abdomen is opened under local anesthesia (as recorded in 2 instances by Matsuo (30)) contraction of the human gall bladder may be observed 5 minutes after the administration of magnesium sulphate. Also in the abdomen of cats opened under local anesthesia I have frequently watched contraction of the gall bladder lasting for several minutes after the intravenous injection of 0.001 milligram of adrenalin. This consists of a slow puckering of the surface, a characteristic bleaching of the wall due to its changing density and a gradual withdrawal of the whole vesicle from the margin of the fossa in which it lies.

It is also true that fully contracted normal gall bladders are rarely if ever encountered in the operating room but this is a direct consequence of not feeding patients before operations. Previous to the introduction of antisepsis however empty gall bladders were frequently observed at autopsy. Even Galen knew that gall bladders were not of one size but found them in his dissections of animal sometimes very full, sometimes empty and sometimes in an intermediate state (17).

A notable exception to this is the gall bladder of the dog which only partially empties after meal—usually not more than half its contents although on one occasion I was able to induce the evacuation of all but a cubic centimeter of its contents by a mixed meal (Fig. 5B). Unfortunately this species is the one which has been worked upon more than any other so that doubtless it is familiarly with this animal which led Carlson to conclude that the role of the gall bladder as the storage organ for the bile has been greatly exaggerated (12). The

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peculiarity of the canine gall bladder has never been explained but quite likely it is a consequence of its relatively larger size as compared with that of man, the cat and the guinea pig—3 species in which it completely empties after a meal of egg yolk. According to Wakerlin the average volume of the bile reservoir of the dog is 15 cubic centimeters whereas in man it probably averages less than 45 cubic centimeters. In 4 patients whom I have visualized the estimated volume excluding the neck of the gall bladder averaged 30 cubic centimeter. The smallest one with which I have worked (Fig. 1) held 16 cubic centimeters and emptied nine tenths of its contents in 16 minutes after a meal of egg yolk and cream. In the next 50 minutes it partially filled and thereupon emptied again. Whether the third filling was followed by emptying could not be ascertained (Graph C p. 35, reference 8). It is not surprising therefore that complete evacuation of the gall bladder in dogs occurs only rarely. Nevertheless the mechanism is capable of greater response for I have recently shown that the gall bladder of the dog can be virtually emptied by repeated intravenous injections of a highly purified lecithin. (See supplementary note at end of article.)

Again the relatively small size of the gall bladder has been seized upon as evidence that this organ could not hold all the bile that is secreted in 24 hours and that it could not therefore function as a storage organ. But we now know that no such demands are made upon it for much of the bile secreted by the liver passes directly into the intestine more or less continuously for a time following meals and at longer intervals during fasting. (2) Within the last few years it has also been shown that the gall bladder has great concentrating power (5) and that frequently it discharges part of its contents during fasting (6) and all or much of its contents after meals (4).

Another argument that is often cited is the fact that the gall bladder may apparently be removed with impunity. Yet cholecystectomy frequently results in well recognized digestive disturbances (14) the first effect of extirpation being the dilatation of the extrahepatic ducts (24). Also change in pressure conditions after removal of the gall bladder is said to predispose patients to an earlier appearance of bile pigment in the blood should the common duct become occluded (8).

Finally congenital absence of a biliary reservoir in certain species of mammals has been cited as evidence that the human vesica

fella is useless—notwithstanding the fact that no studies have ever been made upon the rate of flow of bile from the liver in such species. Yet it is conceivable that both the latent period of this flow and its rate differ from the human and that these differences may be compensatory to the loss of a biliary reservoir. Furthermore it has been shown that the bilirubin concentration of the bile taken from the common hepatic duct of an animal which has no gall bladder is the same as that from the hepatic ducts of one which has a concentrating organ—the mouse (16).

As a corollary to this may be added a hitherto unpublicized observation of the writer. Last spring I had the good fortune to find a clear case of congenital absence of the gall bladder in an anesthetized cat with which I was working. After inserting a cannula in the common duct sufficient yellow hepatic bile was collected to permit a colorimeter test by John of the Harvard Medical School to whom the sample was handed for analysis. When compared with a sample of yellow hepatic bile subsequently collected from the hepatic duct of a normal cat the bile from the animal without a gall bladder was found to be 10 times more concentrated than the bile drawn from the hepatic duct of a normal cat. If we may judge from one case it would thus appear that when the gall bladder is lost early enough in fetal life the deficiency is partly overcome by a compensatory mechanism.

All of which goes to prove the importance of a concentrating mechanism. Indeed it was the convincing demonstration of the concentrating function of the gall bladder by Kous and McMaster in 1911 which initiated a reluctant return to the historical conception of the gall bladder as an important organ of digestion. A second step in this direction was made when the sequence of events following the eating of a meal was set forth.

#### THE EMPTYING OF THE GALL BLADDER AFTER MEALS

Although it had long been recognized by physiologists (16) that ingestion of mixed foods is followed by the entrance of bladder bile into the duodenum it was not until 1923 that the matter was given an exact status by the discovery of a simple food (egg yolk and cream) which regularly and consistently empties the gall bladder of its fluid contents (3).

This information was obtained by the rather crude method of killing a large number of animal at regular intervals following meals. Two years later (4) on applying the new Graham method of cholecystography to this problem it was discovered that egg yolk and cream produced the same complete emptying of the human gall bladder (Fig. 2).

During the first year the writer has studied the effect of this diet on 4 healthy young men and women of the student class. In this large series of individuals X-rays were taken at short intervals after food until the gall bladder shadows disappeared, then the changing volumes of bile were computed and contraction curve for each individual constructed (Fig. 3).

Only the fundus of the gall bladder may be seen in the shadow of the neck usually hidden in the another plane. In calculating luminal cystogram in the transverse section of the circular plinth the assumption being that the gall bladder is circular in cross section when under traction and the volume of the plinth then computed by the well known formula  $\frac{\pi D^2}{4}$ . The process may be considerably shortened by the use of graphical method.

The standard diet consisted of 15 w egg yolks and half a pint of cream the latter being the mixture of the fat soluble lipophilic accreting the initial cost of B. T. H. K. L. A. C. both in an animal and in a human effect as when mixed with cream. Since the time it is the only creature natural for the human has been found to empty the mammalian gall bladder consistently and completely within 1 or 2 hours in the case of a specific food. But many fat containing food and meats have a considerable though less effect. In the case of the egg yolk, due to the emulsified fat, the effect is that it is a complete mixture of the fat and oil which it retains in solution in the stomach that it is of it are being discharged into the duodenum for 6 hours (5) and the keeping of the gall bladder under stimulation for a considerable period during which time it is usually emptied of all its contents although retention and re-emptying may also

der being somewhat smaller but discharges faster (after egg yolk) than that of the male (8). Thus in 1 young woman the quickest time in which the gall bladder discharged 1 cubic inch of bile averaged less than 30 minutes whereas in 1 young man an average of 32 minutes was required with the consequence that as much bile was discharged by the female gall bladder in the first half hour after a meal as by the male gall bladder in the first 45 minutes. In attempting to analyze the individual and sex differences it was found that the initial acidity of the stomach the rate at which the stomach emptied or the length of time required for a meal to pass through the intestinal tract did not affect the rate of emptying of the gall bladder (9). Chronic constipation and menstruation were found to be without demonstrable effect.

One of the most striking features however is the very short latent period of contraction—usually less than 2 minutes after the ingestion of egg yolk and cream—almost simultaneously with the passage of food from the stomach (Fig. 3 and 4). Since the presence of bile in the duodenum is known to irritate the flow of pancreatic juice (McLennan, 1913) its discharge from the gall bladder at the very beginning of a meal has therefore a double significance.

As a result of these new observations it has become clear that the human gall bladder is designed to empty the bulk of its concentrated bile during the first hour of digestion and that it completes its work as a rule before the secretion of bile from the liver reaches its maximum flow, 3 and 4 hours after a meal (6). There is provided therefore an intricate mechanism by means of which the intestine is supplied with an almost continuous flow of bile from the moment that food enters the duodenum until the time when the last of the food leaves the stomach.

In spite of these facts however there are still investigators who claim that the lessening amount of bile in the gall bladder after a meal is due to the concentration of bile within that viscus. In refutation of this it is merely necessary to point to the speed with which the volume of the human gall bladder may be reduced—3 patients for instance

In the course of this study many new facts about the human gall bladder have appeared. First the discharge of bile from the gall bladder is intermittent in character the first contraction phase being the most important one. Apparently too there is a sex difference in the evacuation of this organ—the female gall bladder

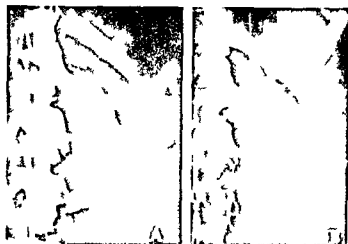
having discharged 1/3 cubic inches of bile in the first 15 minutes of a meal (e.g. Fig. 3). Furthermore in favorable cases the presence of iodized bile in the cystic duct (Fig. 10B) may be observed in human cholecystograms (5, 6). If this be not sufficient, skeptical readers should employ Whitaker's method of filling the gall bladder of an experimental animal with iodized oil and watch the expulsion of oil under the fluoroscope (5, 6).

## INTRINSIC VERSUS EXTRINSIC FORCES

Notwithstanding this belated restoration of the gall bladder to a position of importance many investigators are unwilling to admit that bladder bile is expelled by the contractile force of the tunica muscularis. The substitutes which have been offered are numerous including respiratory and intra abdominal pressures the swelling of the liver during a distention the pumping action of intestinal peristalsis the recoil of the elastic wall of the distended gall bladder and the flushing action of the hepatic bile as it enters and leaves the cystic orifice. Very recently it has been proposed that the matter be compromised by merely adding the action of the gall bladder musculature to all these other factors none of them being emphasized above the others (19). But as matters now stand it has been repeatedly shown by several investigators that expulsion of bile from the gall bladder can be induced experimentally when all these forces except the muscle tunic have been eliminated. It would seem therefore that those who advocate the considerable potency of any of these extrinsic forces are now in the same position as those investigators who formerly maintained on insufficient evidence that the gall bladder musculature was the effective agent—namely are called upon to demonstrate that the forces which they advocate can promptly discharge any considerable amount of bile without the aid of any other agency.

With this introductory statement it is now appropriate to consider the accumulated evidence upon which is based the assertion that the muscle tunic alone is sufficient to empty the gall bladder.

<sup>1</sup> Amount of muscle in gall bladder call  
There is sufficient smooth muscle in the wall



En i sel til l v t ram illu trating v r ay il  
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of the gall bladder to expel the bile. In the biliary vesicle of the cat for instance there is as wide a tunica muscularis as in the small intestine of that animal—although the fibers in the latter organ are picked much thicker. Before we learned to induce emptying of the gall bladder by the use of appropriate foods estimates of the thickness of the muscle tunica were made from sections of distended vesicles and obviously afforded inadequate means of comparison. Thus Hendrickson's studies on the musculature of the biliary tract have been quoted by those who were not familiar with the histology of this region to prove that there is only a small amount of smooth muscle in the gall bladder of the dog (11). But he prepared his specimens by injecting a macerating mixture into the common bile duct until the walls of the gall bladder were distended. In Figure 5B a section through a contracted vesicle of a dog is shown which demonstrates the substantial thickness of the smooth muscle tissue in this species. But even in fully distended vesicles there can be no question as to the amount of muscle (Fig. 6).

2. *Physiological studies of the tunica muscularis* The muscle tunic of the gall bladder exhibits all the common physiological characteristics of smooth muscle including the power of spontaneous rhythmic contraction. Since the classic experiments of Doyen in 1893, physiologists have repeatedly demonstrated rhythmic pressure changes within the

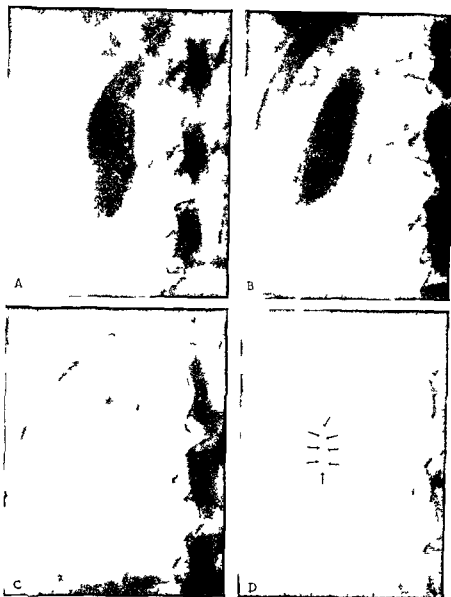


Fig. Ca C I B S le t d chol y t gram ll t t p d mpty f th  
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 lum 5 7 b t m t D 6 5 m t s f t t lum 3 3 c b t  
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gall bladder which can be attributed to one source only the activity of the tunica muscularis. Beginning with Doyen graphic record of these contractions have been obtained by introducing balloons attached to various kinds of manometers the gall bladder being either *in situ* or separated from the liver or even removed from the body. The e studies have been supplemented by experiments testing the

action of drugs upon strips of gall bladder muscle isolated in physiological salt solution. In most of the cases in which it was observed *in situ* care was taken to prevent contact with adjacent viscera and to eliminate respiratory pressures. Using such methods in dog Bainbridge and Dale (1) established the rate of contraction as 1 to 3 undulations per minute. Okada (31) found it to be from 2 to 5 per

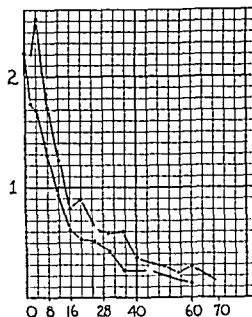


Fig. 3 Two contraction curves made from the same individual (Ca N B B) illustrating the precision with which the human gall bladder responds to a meal of egg yolk and cream. The curve at the left was reconstructed from X rays made with the patient lying continuously upon a table. The one at the right was made one month later with the table rotated to a vertical plane in which the patient continuously in an upright position. For original X ray see Figure 7. In other respects the conditions were constant. Apparently gravity does not affect the rate of emptying. Incidentally this series represents the fastest emptying time recorded in any young man. Ordinates represent cubic inches of bile abstracted in minutes after a meal of 5 egg yolks and a half pint of cream poured (in contraction curve) successive X rays. For data on rate of emptying of stomach and intestine in this individual see Figure 1 (N B B) bibliography 9.

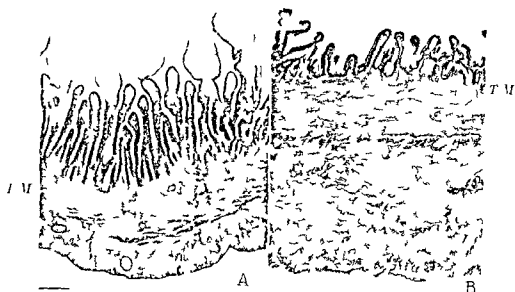
minute but noted that the rhythmic activity was much more marked following a meal of horse meat. In the most recent study that of Taylor and Wilson (35) the rate was placed at from 2 to 6 contractions a minute, i.e. somewhat faster than that of the stomach. These authors brought out the further interesting facts that the gall bladder rhythm was very sensitive to such conditions as chilling, anesthesia and manipulation of either the organ itself or the duodenum but that intravenous injections of adrenalin greatly increased the amplitude of the contractions. This latter observation is very significant and is in accord with the writer's discovery that intravenous injection of adrenalin causes more pronounced momentary expulsion of iodized oil from the gall bladder than that of any other drug—the contraction being visible to the naked eye in animals with the body cavity opened under local anesthesia.



Fig. 4 Selected cholecystograms of a young woman (Ca N H H) showing change in shape of gall bladder after a meal of egg yolk and cream. Patient X-rayed in upright position continuously for several hours after eating. A 2 minutes after eating, volume 36.7 cubic centimeter. Note varying shape and greater concentration of dye in body and fundus. B 13 minutes later, volume 16.5 cubic centimeter. Note more uniform density and shape of gall bladder at 15 minutes after eating. Also note the rapid rate at which it empties against gravity.

3 *Changes in shape following meals.* A third line of evidence is the change in shape which the gall bladder undergoes following meals—a change which can be interpreted as due only to contraction. This has been demonstrated both in the human body and in animals. In X rays of the human gall bladder the first significant change usually appears in the fundus (Figs. 2 and 4; see also earlier papers 5). Previous to a meal the pear-shaped sack appears relaxed as if sagging under the weight of the iodized bile. But often within 2 minutes after a meal the fundus narrows as if the bile were being lifted by compression from the bottom. Sometimes this is sufficient to reverse the shape of the organ—the fundus becoming narrower than the body.

The writer cannot advocate strongly enough the importance of X raying patients after meals as well as before as a routine procedure in roentgenological departments. The simplest method would be to have pictures made every 5 minutes during the first half hour after the patient drinks a pint of milk. This diet would not completely empty the gall bladder but would cause the first and most important phase of contraction when the gall bladder delivers over half of its contents (6). There are several reasons for adopting this procedure: first to test the



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 d m a t u l l f l l f m u a t h g a l l b l d l h r t n d n f l u d  
 n l f y t b f m a d g z h a f t m l f g y l k a d m a t  
 G l l b l a d l n t d u b c e n t u m t f y l l l d N o t d f l p p t i n  
 f t u n a c m p d u t h t h c f t h c t ( f n d B a m m t u t i o n )

contraction rate second for the purpose of interpreting the normal shape of the gall bladder and third a means of detecting abnormalities and adhesions (7). During fasting the gall bladder is usually flattened and its shape subject to distortion by surrounding organs. Soon as contraction sets in and bile is expelled it rounds up and tends to straighten out before reaching the neck and cystic duct (Fig. 10).

In animals the contraction of the gall bladder has been studied by a variety of methods. Whitaker working with cats and employing his own iodized oil method has published X-rays which show contractions in the neck, body and fundus of the gall bladder following a meal of egg yolk (Fig. 8 and 9). He also observed these changes taking place under the fluoroscope (6). Higgins and Mann having opened the body cavity of the guinea pig under local anesthesia observed the bladder for several hours as it diminished in volume after a meal of egg yolk. They found that at first there were several centers of contraction which induced a variety of patterns but that later the independent areas gradually merged to effect the reduction of the whole organ (21). Finally they found

that stimulation with an induction current produced marked contraction of the gall bladder (22).

4. *Critical experiments.* Actual expulsion of the contents of the gall bladder in response to smooth muscle drugs, adrenalin and food have been recorded under experimental conditions which rule out the action of extrinsic force. McMaster and Elman (27) for instance excluded these factors by means of an ingenious system of triple intubation. Three separate tubes being inserted in one animal—the first in the cystic duct, the second in the upper part of the common duct and the third in the lower part of the choledochus. After feeding the animal they were thus able to record simultaneously the flow of bile from the gall bladder into a manometer, the amount of bile secreted by the liver, the resistance to the intestinal wall, the work was the amount of bile at least to tubes being inserted so that no bile could pass from the organ trained to

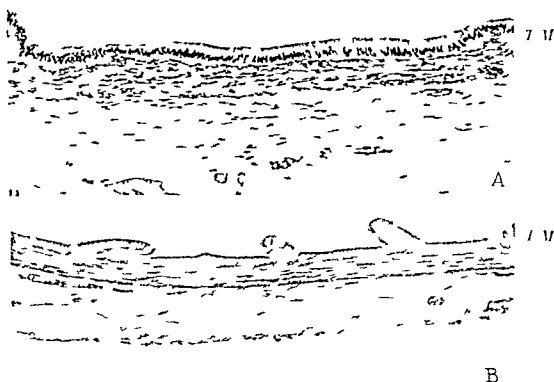


Fig. 1 Photomicrographs illustrating thickness of muscle layer *M* in full distended gall bladders: *A* from 9 months old child (by courtesy of Dr Halpert) *B* from an adult cat (*A* and *B* same magnification)

operate and were in normal condition at the time of the experiment. Under such favorable conditions these investigators were able to demonstrate the sequence of events following the ingestion of food. They found that immediately after eating there was an abrupt increase in pressure within the gall bladder (100 to 15 millimeters of bile) and simultaneously a relaxation at the duodenal orifice of the common duct. In an accessory experiment on the same animal they measured the amount of bile emerging from the intubated gall bladder instead of recording the pressure changes by a manometer. In contrast to the abrupt emergence of bile from the gall bladder there was no immediate increase in the flow of bile from the liver and when it did begin it was gradual. Since Kelling had shown that 300 grams of food could be eaten by a dog without increasing the intra abdominal pressure owing to a compensatory relaxation of the abdominal muscles intra abdominal pressure was not a factor in the expulsion

of bile from the gall bladder. Nor could it be attributed to the flushing action of hepatic bile nor to the sucking action of peristalsis since the manometer tube was connected to the cystic duct only. The conditions of the experiment therefore permit but one conclusion namely that the bile was expelled from the gall bladder by the action of its muscular tunic in response to the ingestion of food.

Balloon experiments with the gall bladder of the dog have been a favorite pastime of physiologists and surgeons up to the present writing. Many who have restricted their observations to manometer readings have inferred that the pressure changes induced by the admitted contraction of the gall bladder around the balloon were not sufficiently great to expel the bile. But they have not taken into consideration the damaging effect of all forms of general anesthesia upon gall bladder action nor the quantitative difference which quite likely distinguishes the contraction in the dog from other species such as man in which the whole viscous has been known to empty in 15 minutes (Fig. 1). In the opinion of the writer the work of McMaster and





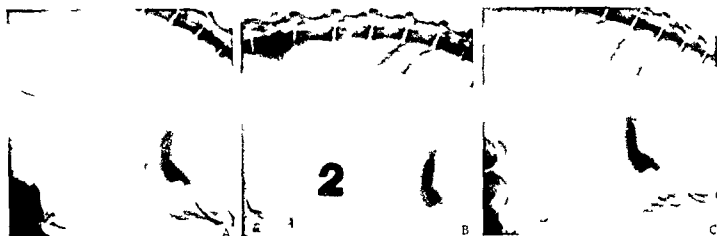


FIG. 8. X-rays of an experimental animal (Cat 1) in which the gall bladder was filled with iodized oil and the bile duct covered so that iodized oil was leaking out into the body cavity at the time the abdominal wall was sutured. 12 hours after the operation. Note iodized oil in the body

cavity. B 4½ hours after operation. Gall bladder not yet emptied notwithstanding the fact that the bile duct has been covered. C 15 minutes after meal of egg yolk. Note bile in cystic duct.



FIG. 9. Experiment similar to that shown in Figure 8 excepting that a funnel was placed in the common duct to insure free exit of bile into the body cavity (Cat K). A One half hour after operation. B 3½ hours after operation. Iodized oil stuck in the common duct is the same as that seen in Figure 8. Gall bladder has

emptied little if any during this time. C 40 minutes after egg yolk. Note constriction in the fundus of the gall bladder and continuous column of oil from the fundus to the end of the common duct showing response to food in spite of the fact that the connection of the gall bladder with the duodenum has been interrupted (cf. figures reference 9).

when the wall of the gall bladder was damaged by squeezing it with clamps the viscus failed to empty in proportion to the amount of injury. Obviously the action of intra abdominal pressure upon the gall bladder would not have been interfered with by this procedure. And within a few months Spurling and Whitaker (33) have shown that patients who were subjected to operations for drainage of the gall bladder (merely cholecystostomy) never recovered the ability to empty the gall bladder—the inference being that the muscle tunic was permanently impaired.

Continuing the work on cats the author sought to eliminate by two methods every factor but that of the gall bladder muscula-

ture. The first of these (5) consisted in filling the gall bladder with iodized oil and then tying the common duct just below the entrance of the cystic duct. Since several hepatic ducts opened below the point of ligation the animals did not become jaundiced. But tying the duct eliminated the effect of intestinal peristalsis and sphincter action. Also since no bile could escape from the gall bladder into the intestine many experiments could be tried on the same animal (starting with the gall bladder in the same state of distention) thus permitting a comparative study of different reagents. The day after the operation when the cats were in good condition purring and moving about the gall bladder was X-rayed



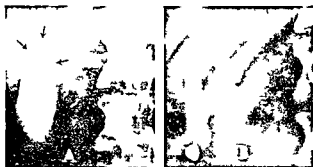
culture after the sphincter papilla had been removed

In conclusion therefore it seems reasonable to assume that in the cat, dog, guinea pig and man bile is expelled primarily by the contractile force of the muscle tunic of the gall bladder. With this fact assured the immediate problem of the future is to find the mechanism by means of which the gall bladder musculature itself is activated and how the flow of bile from the common duct is regulated.

**SUPPLEMENTARY NOTE.**—Since this article was submitted several important contributions to this subject have appeared in the literature. Chief among these is the convincing demonstration by Ivy (Proc Soc Exp Biol & Med 1927 xiv Nov.) that evacuation of the gall bladder in the dog may be secured by intravenous injections of a highly purified secretin. This seems to establish the fact that after food contraction of the gall bladder is a function by a humoral mechanism originating in the mucosa of the small intestine.

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special form of stimulation was required. When that was applied the gall bladder responded (Figs. 8 and 9).

The suggestion may be advanced by those who are familiar with the recent work of Luetkens (10) that the failure of the gall bladder to empty in the animals after the duct is severed is due to a spasmodic contraction of the neck of the organ induced by operative shock. This presupposes a special thickness of the circular muscle to form the so-called colliculus sphincter. But longitudinal sections of the cat gall bladder made with this purpose in view show no increase of thickness in the muscular region. Also Dr. Halpert (11) found that the same is true of the human gall bladder and that if anything the muscle of this is thinner.

No changes in shape occurred before the experimentation showing that intra-abdominal or respiratory pressures or elastic tissue in the gall bladder wall were unable to raise the column of heavy iodized oil. But as soon as food was given the gall bladder elongated sustaining the column of heavy oil for 4 hours. It was also found that skin irritation (such as was induced by shaving the animals' legs) or protein shock (caused by blood transfusions) also produced a temporary elongation as did intravenous injections of smooth muscle drugs and adrenalin—the latter causing marked expulsion of the oil into the cystic duct against the secretory pressure of the liver.

In a recent series of experiments the same results were sought by another method. At the time that the gall bladder of the cat was filled with iodized oil the common duct was either severed or slit open or a cannula introduced so that the contents of the gall bladder could empty freely into the peritoneal cavity. By thus interrupting the common duct any possible pumping action of intestinal peristalsis was prevented. In each case before the body cavity was sewed up it was ascertained that bile and iodized oil (which had just been injected into the fundus of the gall bladder) were leaking out of the incision in the common duct. But in no instance did the gall bladder empty the day of the operation as would have been the case if elastic tissue or intra-abdominal pressure or the sluicing action of the hepatic bile had been effective. Each time some

The writer has placed considerable emphasis on this capacity of the gall bladder to react to food stimulation when its connection with the duodenum has been severed on account of the persistent efforts of certain investigators to explain the discharge of bladder contents primarily to the opening of the pylorus at the outlet of the common bile duct. The mechanical action of intestinal peristalsis (12) has even attributed the contents of the gall bladder to lowered tone of the duodenum caused by the presence of that portion of the intestine. Yet thereby called attention to the lesser effectiveness of the intestinal muscle after a meal he nevertheless retains intestinal stasis as the chief evacuating mechanism of the gall bladder. Equally illogical are those who have sought to minimize the role of the gall bladder musculature and insist in denying the existence of a valve at the end of the common duct. If these contentions were true the precision with which the human stomach responds to the ingestion of food would be utterly inexplicable. It is not necessary to accept either of these views. Within a few months Mann and his associates have demonstrated a sphincter at the junction of the common duct in the dog, lies some distance behind the pylorus, nullifying the conclusions of the investigators who have sought to establish that the filling and emptying of the gall bladder were controlled by the



Fig 1 X ray of Case 2 showing left catheter in renal pelvis and right catheter obstructed at sacro iliac synchondrosis. No shadow seen which would suggest a calculus

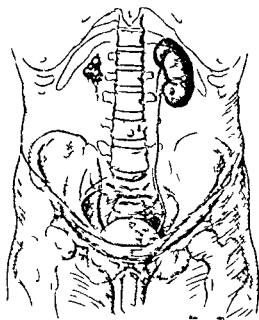


Fig 2 Schematic drawing showing nodules of rudimentary renal tissue in right kidney region of Case 2. Nodules connected by fibrous band. Lower portion of ureter patent to sacro iliac synchondrosis. Upper portion not found at operation

under the stress of carrying on all the excretory function the solitary kidney becomes damaged whether by nephritis, calculus or infection. Ballowitz stresses the frequency of calculus formation in the solitary kidney while the combined statistics of Ballowitz, Moore and Anders indicate that a greater than the normal percentage among subjects of congenital single kidney die of kidney complaints. Anders also found that in 42 per cent of the cases in his series the single kidney showed advanced lesions of chronic nephritis.

Throughout this discussion we have used the term aplasia to mean incomplete development. This we believe would also include both the absent and the rudimentary kidney. The differentiation being only a matter of degree.

The cases we have to report are as follows:

**CASE 1.** Mrs P. L. age 19. Case No 59124. She was admitted to the hospital July 16, 1936, suffering from pain in the right lumbar region of 4 days duration. The attack had commenced with aching pain in the right lower quadrant of the abdomen followed shortly by similar pain in the right lumbar region

and more acute attacks radiating down the right leg. The following day the patient developed fever and chills and a frequency by day every half hour voiding small quantities and with marked burning of urination. She gave a history of right sided pain with fever and chills during her first pregnancy 3 years previously but had no such symptoms during the second. She was admitted to the hospital on the day following the onset of her symptoms and on examination appeared to be in marked pain with frequent rigors and a temperature of 103 degrees. There was marked tenderness in the right costo-lumbar angle also over the whole right side of the abdomen. The right kidney was easily palpable enlarged firm and tender. The left kidney was not palpable nor tender. There was no abnormality of the external genitalia. The urine was cloudy straw colored 1010 specific gravity and acid in reaction albumin+ sugar 0. Microscopically there were present epithelial cells motile bacilli pus++ but no red blood cells or casts.

One cubic centimeter of phenolsulphonephthalein intramuscularly gave first hour 10 per cent second hour 25 per cent total 35 per cent.

On cystoscopy the bladder mucosa was found to be slightly inflamed. The right ureteral orifice was normal in position and appearance but the left was not made out. The right ureter was catheterized to the renal pelvis and a specimen was obtained which showed microscopically epithelial cells pus++



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few red blood cell and colon ba ill \ ray with catheter at the left ureter hooded the tip of the catheter at the level of the third lumbar vertebra. No shadow was made out which could suggest calculus. A large right kidney shadow was noted with no evidence of a kidney shadow on the left side.

The condition remained unchanged with temperature ranging between 94 and 100 degrees. The following day a decapsulation and nephrotomy was performed. It was noted then that the kidney was approximately double the size of a normal kidney. No abnormality of the pelvis was noted. She was discharged 3 weeks later with the wound healed. The renal function was shown by the phenolphthalein test (cubic centimeter intramuscularly) giving 10 percent at first hour, 40 percent second hour, 30 percent total, 80 percent.

She was readmitted a month later still troubled with pain in the right side, some tenderness over the bladder, and a frequency by day, 5 to 6 times, night once accompanied by burning urination.

On examination at this time there was tenderness in the right costolumbar angle and the right kidney was enlarged firm and tender. There was slight tenderness along the course of the right ureter and over the bladder. The urine was clear, straw-colored, no specific gravity, acid, a faint trace of albumin was present but no sugar. Microscopically there were a few red pus cells and some epithelial cells. The phenolphthalein test (cubic centimeter intramuscularly) gave 10 percent at first hour, 50 percent second hour, 20 percent total, 80 percent.

The blood urea nitrogen were normal. Blood urea 4.0 grams per liter of blood, blood urea nitrogen 10.6 milligrams per 100 cubic centimeter of blood, creatinin 1.0 milligrams per 100 cubic centimeters of blood. Cystoscopy at this time showed the bladder mucosa to be slightly inflamed and granular.



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The right ureteral orifice appeared normal. The left ureteral orifice could not be found. In fact there seemed to be an absence of the trigonal ridge on that side. The right ureter was catheterized to the renal pelvis and clear amber urine was obtained containing a few red blood cells and white blood cells. Culture of this specimen gave no growth. A pyelogram with 4 cubic centimeter of 12 percent sodium iodide solution in the right pelvis showed a very large kidney shadow with only a partly filled large renal pelvis. Indigo carmin injected intravenously appeared from the right side in 5 minutes but none appeared from any portion of the left side of the bladder or urethra.

CASE. Mr. H. W., age 31, admitted July 30, 1910. When he was admitted to the hospital he complained of a frequency which he had suffered from for the last 3 years. Four days previously he had an attack of colic like pain on the right side and later found that at the time he had burning on urination. He gave no other history of symptoms. As a child he had suffered from infantile paralysis of the right lower extremity and chick pox. His general examination was negative apart from some atrophy of the left leg and paralysis of the muscle below the knee. The blood pressure was 120/80.

Examination of the genito-urinary system showed no costolumbar tenderness, the kidneys were not palpable, there was slight ureteral tenderness on the left side but none on the right. There was no suprapubic tenderness or distention. External genitalia

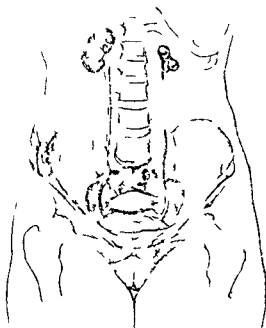


Fig. 3. Schematic drawing showing two cysts connected by fibrous band in lower portion of ureter of patient with upper portion absent.

and prostate were normal. His urine was clear straw colored specific gravity 10.0 and some albumin was present but no sugar. Microscopically there was pus bacilli motile epithelium and calcium oxalate crystals.

His renal function by the phthalein test intramuscularly given was apparently normal first hour 35 per cent second hour 15 per cent total 50 per cent. Blood Wassermann was negative. No tubercle bacilli were demonstrated in the bladder urine on several examinations.

X-ray of the kidney and bladder region showed a small round shadow opposite the fifth lumbar vertebra on the right side.

At cystoscopy the bladder mucosa was found to be slightly inflamed. The ureteral orifices in normal position appeared slightly gaping. The left ureter was catheterized to renal pelvis and a specimen was obtained. The right ureter could be catheterized for only half the distance and no specimen was obtained. The specimen from the left kidney showed an occasional red and white blood cell and a few epithelial cells and culture gave a growth of bacillus coli communis. X-ray with catheters in position showed the left catheter up in the renal pelvis but the right only at the sacroiliac synchondrosis. No shadows were seen suggestive of calculus or of the previously noted shadow. A second cystoscopy confirmed these findings also. Indigo carmine injected intravenously appeared from the left side in 5 minutes but none from the right side in 15 minutes (Fig. 1).



Fig. 4. Photomicrograph of section from cyst wall in Case 3. Connective tissue predominant with here and there nests of partially and completely developed tubules and glomeruli. Several of the tubules contain casts. Low power.

The diagnosis was made of a probable closed tuberculous lesion of the right kidney and operation was performed on August 6, 1925. On exposing the right kidney only a small mass of fat and fibrous tissue was found containing several small nodules of a firmer tissue. Attached to these were several small blood vessels. No ureter could be found. The mass of tissue was removed from a small indefinite pedicle. There was no other evidence of kidney tissue (Fig. 5).

Report of examination by Dr. Waugh of the Pathological Department was as follows: Specimen consists of a mass of reddish tissue of rubbery consistency about 30 grams in weight. At one end is a cyst with a smooth pale wall. It is the size of a small walnut.

Sections of the tissue show it to be made up of an irregular mass of loosely arranged fibrous connective tissue containing numerous larger and smaller blood vessels. There are occasional peculiar duct-like structures containing blue staining more or less homogenous material and lined by small irregular cells having little resemblance to epithelium but probably being atrophic degenerated and necrotic undifferentiated lining.

The cyst wall consists of a wavy fibrous connective tissue without epithelial lining. Hyaline fusion of the fibrous connective tissue is occasionally seen. There



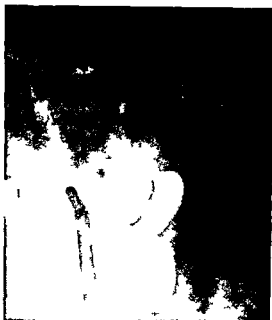


Fig. 1. X-ray taken by cystoscopic method. Cystoscopic right catheter obstructed by blood clot. Left retrograde pyelogram shows normal renal pelvis and calyces.

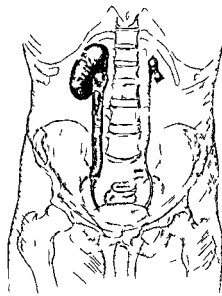


Fig. 2. Shmidek's drawing of the left kidney. The left kidney is shown in the retrograde position. The right kidney is shown in the normal position. The left kidney is shown in the retrograde position. The right kidney is shown in the normal position. The left kidney is shown in the retrograde position. The right kidney is shown in the normal position.

1. no evidence of inflammatory change in the tissue. Diagnosis: atresia of kidney (Fig. 3).

The patient developed bronchopneumonia about 10 days after operation but soon recovered. When heard from 6 months later he was free from symptoms, had gained in weight and strength was able to go about his work as usual. He has had no recurrence of pain on the right side since his operation.

CASE 3. Mrs. D. F., age 33, admitted to hospital complaining of severe pain in the left loin which had awakened her from sleep 4 days previously.

Frequency of voiding 8 times and night of course had appeared 3 days later. Slight burning accompanied micturition. She gave the history of having had an attack of acute pyelitis on the right side 4 years previously and had suffered from a slight dragging pain on that side for the past 6 months. She had one child 10 years of age alive and well. On examination her general condition was normal. Blood pressure was 100/60.

Examination of the urinary system revealed no costovertebral tenderness. The kidneys were not palpable and there was no tenderness over the kidney or along the course of the ureters. The epigastric and suprapubic tenderness. The genitalia were normal externally and by vaginal examination.

The urinary sediment was of a hazy, straw-colored supernatant. A few acid-fast tubercle bacilli were found in the sediment. A few white blood cells and a few motile bacilli. No tubercle bacilli were found in

the bladder urine. X-rays of the kidney and bladder region were negative for calculi.

One cubic centimeter of phenol sulphophthalein given intramuscularly and 65 per cent was excreted in 2 hours.

The blood urea findings were normal. Blood urea 28.8 mgms per liter of blood. Blood urea nitrogen 13.4 milligrams per 100 cubic centimeter of blood. Creatinine 1.9 mgms per 100 cubic centimeters of blood. The blood Wassermann was negative.

At cystoscopy the bladder mucosa was normal. The ureteral orifices were normal in appearance, shape and position. The right ureter was catheterized to the renal pelvis and a specimen obtained. The left catheter was obstructed in the lower ureter and no specimen was obtained. The right specimen showed cloudy straw-colored urine containing a few red and white blood cells and some epithelial cells. X-ray examination with the catheter in position showed the right catheter in the renal pelvis at the tip of the third lumbar vertebra. The left was at the sacroiliac synchondrosis but no shadow of a calculus was seen (Fig. 4).

A second cystoscopic examination confirmed these findings. A ureteropyelogram was attempted on the left side but no shadow of fluid was seen. Indigo carmine injected into the ureter appeared from the right side in 4 minutes but not from the left side in 15 minutes. The condition was thought to be an advanced left renal tuberculosis and operation was performed.



FIG. 9 Section of nodule in Case 4 showing a matrix of connective tissue with flattened epithelium. Several glomeruli present overgrown by fibrous tissue. Low power.



FIG. 10 Photomicrograph from aplastic kidney in Case 5 showing glomerulus and one tubule enclosed in connective tissue. Glomerulus has been invaded with connective tissue which has undergone hyaline degeneration. Lumen of tubule contains an albuminous cast. High power.

On opening the left loin we saw a small mass of tissue in the kidney bed. This consisted of several rounded cyst like bodies, one the size of a plum, the other much smaller. No ureter could be made out. The pedicle consisting of several small vessels was ligated and the mass removed. The two cystic masses were connected by fibrous tissue bands (Fig 5).

Incision of the cysts revealed a more or less viscous fluid, dark amber in color, about 15 cubic centimeters from the larger and 5 cubic centimeters from the smaller. This fluid showed on examination to have approximately the same findings for urea etc. as for blood. Urea 360 gms per liter of fluid, urea nitrogen 16.80 milligrams per 100 cubic centimeters of fluid, creatinin 1.59 milligrams per 100 cubic centimeters of fluid, sugar .003 per cent.

Examination of the tissue removed showed an irregular dense fibrous tissue with areas of hyaline fusion, containing nests of poorly developed tubules, the lining epithelium of which is swollen so that its differentiation is lost. The lumina are filled with hyaline casts.

Glomeruli are rare and the capillaries in Bowman's capsule are disintegrating. Sections of the cyst wall show it to consist of a thin capsule of fibrous connective tissue having an inner margin of flattened epithelial cells (Fig 6).

Diagnosis: aplasia of kidney with multiple cyst formation of rudimentary tubules.

Patient has much improved, has gained 40 pounds in weight and has been free from symptoms since operation.

CASE 4. Mr D. St. G., age 30, was admitted to the hospital on May 27, 1916, complaining of anuria of 4 days' duration. He had been suffering from slight attacks of pain in both loins for the previous years. These attacks were accompanied by some burning urination. He had a slight attack of pain in the right loin radiating down to the groin shortly before the onset of the anuria. The history apart from this was negative.

On admission the patient appeared in evident distress, though there was no vomiting or nausea and no edema of face, hands or feet, and mentally he was quite clear. The tongue was coated and dry. The eye grounds were normal. General examination was negative.

Blood pressure 110-75.

Examination of the genito-urinary system revealed no costolumbar tenderness. The kidneys were not palpable, though there was slight tenderness in the left loin on bimanual palpation of that side. No masses were palpable in the loins. There was no tenderness along the course of either ureter and no suprapubic distention. The penis was normal in

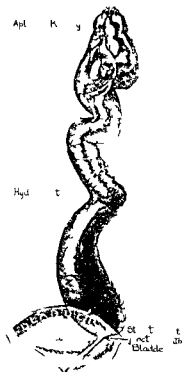


Fig. Ph. t. m. og. ph. f. s. ct. of t. u. from pl. s. t. k. l. y. F. h. th. hv. l. m. of gl. merul. w. th. f. d. lat. d. t. i. l. co. t. n. c. t. Th. g. l. ed. u. d. c. l. nh. l. t. on. f. the. on. ct. ets. L. w. po.

Fig. Apl. t. c. l. f. t. k. d. v. l. hyd. t. r. mo. d. f. om. C. 6. a. l. y. of. y. a. U. t. m. ly. d. l. t. d. and. to. tu. s. th. a. v. t. t. t. t. t. th. l. l. d. d. k. d. y. h. l. l. f. t. t. t. t. t. t. af. w. gl. merul. d. dm. t. y. t. bul.

conformation. No li charge as pre ent. The urethra easily admitt d No 16 soft rubbe cath ter but no uru e v as obtained f om the bla id r. The crutum and co tents e normal I state p r r ctum appeared normal to the e am nng finger. A ray of the k dne y and bladder region li not sho any shado hich ould sugg t a cal ulus.

The blood urea n l n g at the time ere blood urea 1.4 grams per liter of bl od blood urea nitrogen 66.36 milligram per 100 cubic ce t met rs of blo l.

He va treated symptomatically heat to the loins lectric bakr and intra enous sal es of 0 per cent glucose. The follo ng day h h d not voided and a cy t cope l. The bladder a symmetrical the mu osa normal the ureteral orifices ormal in contour a d posit n. The ight ur ter v catheter e l f r a l tance f about 4 centimeters when l t nte ob t ructi n as met. The left ureter as cath te zed f about 15 cent mete s when lei te ob t r t i o n as met. No speci mens of u ne re btane l. A v s tak n ith catl ter i p t h d both n the elat e position ment on d but n had o r seen sugg t e f c i u l. No lei h def ed kidney shalo n. Ph c tos o f a rep ated the f llo ng d n th the am e g at ere ult (Fig.)

On the morning of May 31 he had still not voided any urine and it as seen that h condition was critical. He had become nauseated and was vomitng all fluid taken. He had become oedematous and v a l o some h t cyanosed and dyspnoe. An ope ration as indicated as the last po ible means of reli f as he had not voided for days.

In e of the hi tory of pa n on both sides and the sl ght te derne s n ted on the left side at e am nation that ide a opened i r t. Hi blood rea at th time had r en to blood urea 2.06 grams pe liter f bl od blood u e r n t r o g e n 97.3 millig am pe 100 ubic centimeter of blood.

The opening f the left lo n re ealed the t sues marked ad m atou. No pe irenal cap ule was found a d no kid ey. In the eg on here the k d n v houl be th e s a small ma of fat and fi br u t i u containing everal u ded mas e of firm r t sue. Several m ll es el ente d th so mng a pedicle l r m th ma al o a fibrous co d r do n a l t v ard the bladder. Th mas of t ue s m d (Fig 8).

The ight l n a then ope ed and a sl ghtly la ge th normal kid sou d. The surface ap pear d lightl gr nular and as a darker red than i u uali e. They lvi an l ur te ere markedly l lated and the wall of the u e t r much th ned out. An opening as m d t th u e t i c l e n j u n c t o n a l a large quantity of lear pal u ne escape l. A bouge v a th p ed do n v a l a d met with

obstruction in the pelvic portion of the ureter. This was overcome and a No. 1 bougie was passed to the bladder. A tube was then inserted in the opening in the pelvis for drainage.

His condition improved immediately upon the establishment of drainage. A large quantity of urine drained from the loin for weeks when after the right ureter was dilated to No. 9 the patient voided and several days later the wound became dry. The urine passed was pale and of a low specific gravity 1008.1010. There was some slight infection with colon bacillus following the operation. The small specimen removed from the right side was examined by Dr. T. R. Waugh of the Pathological Laboratory and his report is as follows:

Specimen consists of some fat tissue in which are a few fiblet sized masses of firmer tissue. Section shows irregular masses of fat cells connected by a loose fibrous stroma. In some areas are irregular tubular spaces lined by a regular layer of cuboidal epithelial cells. These large pale cells appear of the embryonic type; the arrangement resembles the anlage of convoluted renal tubules. There are also tufts of cells resembling glomeruli containing red blood cells. There is a dense fibrous tissue stroma surrounding these structures and numerous thick walled vessels are seen. There is no related definite kidney parenchyma although metanephric blastoma with tubular and glomerular formations are found (Fig. 9).

Diagnosis: aplastic kidney; congenital malformation of metanephros.

Patient was seen again in October 1926 when he had gained in weight and strength. He was free from symptoms but his urine was still of low specific gravity and there were scattered pus cells and colon bacilli in the urine. Blood urea 7.5 grams per liter of blood; blood urea nitrogen 33.3 milligrams per 100 cubic centimeters of blood.

When he was seen again in January 1927 his urine still contained scattered pus and was of low specific gravity. The phenolsulphonephthalein output was 20 per cent for 2 hours. Blood urea 660 grams per liter of blood; blood urea nitrogen 30.5 milligrams per 100 cubic centimeters of blood.

The right ureter easily admitted a No. 6 catheter and there was no hydronephrosis.

CASE 5. Mrs. E. M. age 40 was admitted to the hospital first in 1914 suffering from incontinence of urine following a birth trauma which had occurred in 1913. She had complete incontinence of urine. Her general examination was negative; the blood pressure was 146-88.

Cystoscopy showed a small bladder containing about 1 ounce of thick creamy pus. The mucosa was inflamed. There was a large opening toward the right side on the floor communicating with the vagina.

The left ureteral orifice was normal. This was catheterized and normal urine was obtained. No right ureteral orifice could be demonstrated and indigocarmine injected intravenously appeared from

the left ureter but not from the right side nor from any portion of the right side of the bladder. A plastic operation was performed. This was successful for some months but incontinence reappeared.

It was found on the next admission that a small fistula from the bladder communicated with the cervix and a hysterectomy was performed. Examination of the urine from the left kidney showed at this time some evidence of infection. She was admitted to the hospital in 1920 suffering from fever, chills and pain on the left side and also incontinence of urine. A small vesicovaginal fistula was present.

Cystoscopy and catheterization of the left ureter showed an infected hydronephrosis. A catheter in place showed a marked kink in the lower left ureter with the catheter coiled downward toward the iliac crest, evidently a stricture which was resulted from trauma at the time of the hysterectomy.

She again entered the hospital in 1923 in urinary and died shortly after admission.

Examination showed a large distended pyonephritic sac on the left side with the lower portion of the ureter narrowed and bound down in a mass of scar tissue. Examination of the right kidney showed a small mass of kidney tissue about the size of an almond covered with a thick fibrous capsule. The pelvis was small but the ureter appeared about the normal size. About 3 or 4 centimeters from the bladder it was completely stenosed and became lost in a mass of scar tissue about the bladder. Microscopically the kidney appeared to be made up of a mass of fibrous tissue with a few small blood vessels showing hyaline degeneration of their walls. An occasional tubule with flattened epithelial lining and a few glomeruli which had undergone invasion by fibrous tissue were seen scattered throughout the fibrous tissue of which this was mainly composed (Fig. 10).

CASE 6. L. M. boy age 9 years was admitted to hospital May 5, 1924 complaining of frequency by day of five to six times and cloudy urine which had been noted by parents for the past 3 years. He had also suffered from enuresis since childhood. On examination he appeared to be well developed and nothing abnormal was noted. His blood pressure was 108-65. The genito-urinary system on examination showed no costolumbar tenderness; the kidneys were not palpable. There was no ureteral tenderness and no tenderness nor distention of the bladder. His urine was cloudy amber; specific gravity 1020; acid; albumin +; no sugar. Microscopically it showed pus, a few red blood cells and a few cocci. No tubercle bacilli were found in the bladder urine. The phenolsulphonephthalein test: 1 cubic centimeter given intramuscularly showed first hour 30 per cent, second hour 50 per cent, total 52 per cent. Examination of the kidney and bladder region did not show any shadow suggestive of calculus. Cystoscopy showed a rather tight anterior urethra; a No. 18 cystoscope being used. The bladder was symmetrical; the mucosa was slightly inflamed. The right ureteral orifice

was normal. The left ureteral orifice was scarred and gaping. The left ureter could not be catheterized. *Normal urine was obtained from the right side (Fig 11)*

From the age of the boy and the frequency and condition of the ureteral orifice a diagnosis of probable tuberculous kidney was made and operation performed. At operation the left kidney was found to be small scarred with a slightly distended renal pelvis and a markedly dilated and tortuous ureter filled with purulent material and adherent to the surrounding tissues. The kidney and ureter were removed with difficulty. The kidney was a thinned out fibrous sac surrounding the dilated pelvis and ureter. Microscopically it showed a thin wall made up of fibrous connective tissue, a few small blood vessels and the hyaline remains of many glomeruli. A few tubules were also noted (Fig 12).

The patient made an uneventful recovery. He has since gained in weight and apart from one attack of hematuria 6 months later from the ulceration about the left ureteral orifice has been free from symptom.

An analysis of these six cases might prove of interest. From the point of view of sex the numbers are equal there being three of each. The ages are 9, 19, 31, 31, 33, and 40 years.

The left kidney was involved in 4 out of the 6 cases and the right in 2. This agrees with the majority of cases reported. Out of a short series of 18 cases collected by Goldstein the left side was involved in 13, the right in 5 cases.

The symptoms which compelled these patients to seek advice were usually on the side of the remaining kidney although three of these had definite pain on the side of the aplastic kidney and in Case 2 the pain was confined solely to that side. The frequency, burning, and pyuria were in all but one case due to infection of the solitary kidney.

In Case 6 the symptoms were evidently due to infection of the large distended ureter on the side of the aplasia.

In Case 1 the solitary kidney was the seat of an acute pyelonephritis and there was a history of an attack of pyelitis 3 years previously during pregnancy. The kidney in the case was about twice normal size as shown by X-ray examination and at operation.

In Case 3 the remaining kidney was the seat of a low grade chronic pyelitis as shown by a few white cells at cystoscopy and a positive culture of bacillus coli communis. No enlargement of this kidney was shown by X-ray examination.

In Case 3 the patient had suffered from attacks of pyelitis on several occasions. The kidney shadow was not shown to be enlarged by X-ray examination.

In Case 4 there was a period of anuria of 7 days and at operation a slightly enlarged kidney with a dilated pelvis and ureter were found. There was a stricture of the ureter present in its lower third. A similar case was reported by Lindsay several years ago.

In Case 5 the renal aplasia was considered during the examination for the relief of vesico-vaginal fistula and verified at autopsy. The remaining kidney was the seat of infection and following the trauma to the ureter and the resulting stricture a large pyonephros is developed.

In Case 6 the remaining kidney appeared normal in size and function.

There were no associated genital abnormalities in any of these cases.

The bladder was symmetrical in 5 cases. Case 1 showed an absence of the left ureteral orifice and the left half of the trigonal ridge.

The bladder was inflamed in 4 of the 6 cases which could be explained by the acute infection above.

The right ureteral orifice was not seen in Case 5. Whether this was damaged at the time the vesico-vaginal fistula was incised is a question. A stricture of the lower ureter was present in that case and the terminal in the so was lost in a mass of scar tissue.

The ureteral orifices in the remaining cases were in the normal situation.

In Case 6 the left orifice was scarred and gaping evidently in inflammatory lesion.

The ureter in these cases on the side of the aplasia varied.

In Case 1 there was no evidence of ureteral orifice in any region of the bladder, urethra or vagina.

It is reasonable to suppose that the ureter and kidney are completely absent though Lyons reports a case in which a short rudimentary ureter was attached to the bladder in the normal position though there was no ureteral orifice present.

In Cases 2, 3, and 4 there was a short rudimentary ureter present which was patent for some distance. In two cases it ended blindly.

but in the third it was continued as a fibrous cord attached to the aplastic kidney tissue found in that region. In Cases 5 and 6 there was a ureter present throughout dilated thickened and filled with purulent material each structured in its lower portion.

A small renal pelvis was found in these two cases with thickened fibrous walls. No pelvis was found in Cases 3 or 4.

Evidences of renal tissue were found in 3 of these cases. There is no reason to expect any evident traces of renal tissue in Case 1. Many similar cases have been reported (7, 10, 11).

In each of Cases 3 and 4 there was found a small mass of fat and connective tissue containing nodules of firmer tissue and in two small thin walled cysts. The nodules and cysts were connected by bands of fibrous tissue. They were supplied by one or more small blood vessels and in one the fibrous cord passed downward to become attached to the lower and patent portion of the ureter. Section of the nodules of tissue showed a predominating connective tissue matrix containing nests of cells epithelioid in character in many instances forming ducts the lumina of some containing albuminous material resembling cysts. In other portions rudimentary glomeruli could be made out. These were as a rule very few and many were replaced by fibrous connective tissue which in places showed hyaline degeneration. The cyst wall was lined by flattened epithelium and made up of connective tissue fibers. The cyst in Case 3 contained urea, creatinin and sugar in the proportion similar to that found in blood.

In Cases 5 and 6 there was found a definite pelvis surrounded by a shell of tissue composed of connective tissue tubules and a few glomeruli many of which had been replaced by fibrous tissue. Whether these two cases are aplastic in origin or whether they are the result of secondary atrophy is a question not easy to answer. A case similar to Case 6 has been reported by Krotoszyner.

The differentiation between renal aplasia and secondary atrophy is difficult to make histologically. Kaufmann's *Pathology* states

there is no essential difference in the histological picture. Oertel is of the opinion that in a secondary atrophied kidney there

is usually some evidence of a ureter and a pelvis being present.

In all probability Cases 5 and 6 might fall into the class of atrophic cases but whether the atrophic process commenced in a kidney which was normal or in one that was hypoplastic in nature is impossible to say.

Hinman's work as well as that of Barney and of Scott tend to show that ligation of the ureter causes a hydronephrosis rather than an atrophy so that one may assume that these two latter cases are congenital in origin.

### CONCLUSIONS

The conclusions to be drawn from this series of cases may be summarized as follows:

1. Unilateral renal aplasia is not uncommonly seen in urological practice.
2. The lesion appears to be more common on the left side than on the right.
3. There is usually a lesion of the opposite or remaining kidney.
4. There is sometimes unexplained pain on the side of the aplasia.
5. The operation and removal of the rudimentary kidney relieved the pain in 2 cases for some unexplained reason.
6. In some cases nodules or cysts containing renal tissue are found without pelvis or ureter formation.
7. The aplastic kidneys in this series were all functionless.

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## CARCINOMA OF THE OESOPHAGUS

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THE oesophagus is a musculomembranous tube about 5 centimeters (10 inches) in length connecting the pharynx and the stomach beginning at the lower border of the cricoid cartilage between the sixth and seventh cervical vertebra about 15 centimeters from the incisor teeth and ending below the diaphragm opposite the tenth (some times the eleventh) thoracic vertebra. The subdiaphragmatic part is about 3 centimeters long. Four areas of constriction are commonly agreed upon although others have been described. Of these one is at the very beginning, a second at the passage through the diaphragm, a third at the point where the arch of the aorta crosses the oesophagus and the fourth where the latter passes behind the origin of the left bronchus. They all seem to be closely related to the positions at which cancers occur as will be shown later.

The lymphatics of the oesophagus which are of special importance in the explanation and understanding of metastasis of oesophageal cancers are arranged in two networks, one of which is submucous, the other is in the muscular coat. The stems which drain the networks of the cervical portion of the oesophagus pass to the superior deep cervical and retropharyngeal nodes, those draining the thoracic portions of the network to the posterior mediastinal nodes and those originating in the networks of the terminal portion pass to the nodes of the coliac group. From these three groups of nodes there is hardly any limit to the anastomoses of lymphatics in the neck, chest and abdomen, a fact which can readily explain some of the extensive metastases of cancers of the oesophagus. The extensive submucous network of lymphatic will explain in most instances why local lesions may become so large before more distant metastasis occurs. The close proximity of the trachea and bronchi and of their lymph nodes to the oesophagus and to the oesophageal nodes as shown in the photograph will ex-

plain why they so readily become involved particularly in growths situated in the middle third (Piersol's *anatomy*).

For convenience the oesophagus is frequently divided into thirds. The upper third extends from the cricoid cartilage to the point where the aorta crosses the trachea and oesophagus. The middle extends from this point to 4 centimeters below the bifurcation of trachea or about the level of the lower end of the fifth thoracic vertebra and the lower extend from this point to its junction with the stomach opposite the tenth thoracic vertebra. The bifurcation of the trachea occurs about the middle of the oesophagus.

Analyzing 5,000 autopsies performed in the past 5 years at the Philadelphia General Hospital we found 81 cases of malignancy. Of these 41 (50.5 per cent) died of cancer of the oesophagus. Of these 41 cases 39 (95 per cent) were men and occurred in the colored race. The oldest patient was 97 and died of cerebral hemorrhage. The cancer in this case was small and had not given rise to any complaints nor were there any metastases. The youngest patient was 41 and gave symptoms of increasing difficulty in swallowing for 24 months which was the longest duration of symptoms of any of the cases. He had a grade 3 (Broder's) prickly cell carcinoma involving the upper part of the lower third of the oesophagus for a length of 3 centimeters and at time of death it only partially obstructed the lumen of the organ. There was no distant metastasis of the growth but the local extension was of a fairly marked degree involving the trachea, mediastinal lymph gland and surrounding tissues.

Of the 41 patients the average age at death was 60 years and 6 months and the great majority were in their sixties.

## SYMPTOM AND DURATION OF ILL

Difficulty in swallowing was by far the commonest symptom. It occurred in 9 cases and

was one of the first symptoms in 7 occurring very late in 7 and was the only symptom for a long time in 5.

Weakness and loss of weight were early and constant symptoms. They were the first symptoms in many cases and with the exception of one case were practically always present. This patient was a white man 7 years old and did not have any symptoms until months before death at which time he developed a cough with expectoration of bloody sputum. Four days before death for the first time he developed difficulty in swallowing. At autopsy he was found to have a grade 3 prickly cell carcinoma of the oesophagus, 5 centimeters below the cricoid cartilage. The growth was flat and encircled the oesophagus for the length of 1 centimeters. It had perforated into the trachea at this position and had given rise to a large superior mediastinal abscess but the lumen of the oesophagus was only partially obstructed. The patient died of deglutition pneumonia.

Pain and vomiting were comparatively infrequent symptoms. Epigastric pain mostly of a mild degree was present in 7 cases of these 7 showed the growth to be in the lower third of the oesophagus and in each instance to extend into the stomach. In the other cases the growths were present in the middle third but one of them had given rise to metastasis to the liver, coeliac glands and most of the abdominal organs. The other practically occluded the lumen for 5 centimeters but had not given rise to any local extension or metastasis. Only one patient complained of actual pain on swallowing. This pain was of a very severe degree and of a burning character occurring 2 months before death and preceded by 3 months of difficulty in swallowing. The case showed an ulcerative hemorrhagic carcinoma involving the upper part of the lower third for 4 centimeters. The posterior mediastinal glands were slightly involved and there was a very large gland along the lesser curvature of the stomach. The involvement of the structures in this case was not different from many others who did not have pain and we were unable to determine its cause. Pleural pain occurred in 6 cases. In each the perioesophageal tissues and structures were in-

involved in various degrees and pleural adhesions were present.

Vomiting was the earliest sign in 3 cases. Two of these were accompanied by nausea and metastatic ulcerative areas were found in the stomach. Regurgitation occurred in many cases and in each there was more or less obstruction.

Cough was a prominent symptom in 10 cases. In these the trachea, bronchi or lungs were involved or pressed upon with the exception of one where a metastatic mass surrounded the aorta and involved the recurrent laryngeal nerve. In 4 cases the trachea or left bronchus was perforated. There were 2 examples of each.

Spitting of blood occurred in 11 cases in 6 cases from the metastases to the trachea, bronchi or lungs in from ulcerative metastatic lesions in the stomach and in 5 from the oesophageal lesions.

Hoarseness was present in 5 cases. Early symptoms as given in textbooks such as subternal pressure or discomfort or spasm of the cardiac end of the stomach were not mentioned.

Symptoms lasted as long as 4, 2, 17 and 15 months, the shortest duration varying from none at all to 2 or 3 weeks. Three gave no symptoms referable to the oesophagus at all in one the lesion was small in another the lesion involved the middle third for 8 centimeters and had metastasized to the peribronchial and pancreatic lymph glands. The patient was in a moribund condition on admission and the history obtained from relatives who may well have been inaccurate. The third case was a well nourished white man 7 years of age his history was also given by relatives. The oesophageal lesion was small and flat arising in the upper part of the lower third of the organ and metastasizing widely throughout the chest and abdomen. A few cases had symptoms referable to the oesophagus for 1 to 3 weeks. For the most part these growths were flat and produced very little obstruction but were not very different in local character or extent of metastasis from those giving rise to long standing symptoms.

Some of the lesions causing complaints for the longest periods of time peculiarly were



not as extensive locally nor did they metastasize as widely as many of the others. The average duration of symptoms of the entire group was about 7 months. In most of the cases wherever possible and indicated a gastrostomy was performed but seemed to have little or no effect in prolonging life except in cases of obstruction. Twenty-two died of bronchopneumonia, 3 of empyema, 5 of lung or mediastinal abscesses, 1 of pulmonary hemorrhage, and 1 of gastric hemorrhage. The others died of starvation or from metastases of the cancer.

### PATHOLOGY

The description of three cases which exhibit important differences in the extent of the local lesions and metastases are first given.

**CASE 1.** Sh was an extensive local lesion without any metastasis.

A Chinese male aged 48 years, admitted to the hospital May 14, 1925, and died of a term of bronchopneumonia September 13, 1925. He complained of difficulty in swallowing and weakness for 7 months before death. He had lost a great deal of weight and for the past 3 months had vomited frequently but had not complained of any pain or other important symptom.

At autopsy (I G H No. 5010) the upper part of the esophagus was deeply injected. The entire middle third was the seat of a necrotic ulcer which extended entirely through the wall of the esophagus so that the upper and lower thirds were barely continuous. The upper margin of the ulcer was thickened and sharply demarcated from the esophageal mucosa. The lower margin was similar except a narrow, linear-like process of the growth extended down the esophagus through the lower third into the cardiac end of the stomach. Here it presented to an oval shallow ulcer the size of a dollar. The ulcer of the stomach involved the whole thickness of the mucosa, its deep border had rolled but not indurated. Sections at various levels showed it to consist of a soft, feebly white friable and mucohyaline. The nearby lymph nodes were not enlarged and there were no metastases. The lungs were the seat of a fairly marked tuberculo and bronchopneumonia.

Microscopic study revealed a typical follicle cell carcinoma. Broder's classification grade 2.

**CASE 2.** Adenocarcinoma of the upper third of the esophagus with extensive metastasis above the diaphragm.

A white male aged 60 years was admitted June 5, 1922, and died of a terminal bronchopneumonia June 9, 1922. He was always in good health until a year before death when he began to lose weight and strength. He developed difficulty in swallowing 2

months, pain in the right side of his chest 2 weeks and loss of voice 3 days before death.

At autopsy (P G H No. 5444) a tumor was found adherent to the under surface of the sternum at the level of the first and second ribs. The mass sprang from the superior and anterior mediastinum and a number of tumors of bean size were adherent to the posterior surface of the sternum. In the superior and anterior mediastinum the tumor was the size of one's fist. It was of a firm consistency and pale yellow in color, pressing upon the upper part of the ascending aorta, involving the outer wall of the trachea and appearing to have sprung from the upper part of the esophagus. When the esophagus was opened a large firm fungoid mass was found in its upper third arising from its posterior wall and almost completely occluding its lumen for a length of 7 centimeters. The tumor was nowhere circumscribed and had a pale gray yellow color. The rest of the esophagus and stomach did not show any important gross changes, but peribronchial and mediastinal glands were much enlarged and replaced by the tumor tissue.

The lungs were firmly adherent to the posterior thoracic wall, their surfaces being very nodular due to projecting pale white tumor masses. Scattered diffusely throughout each lung were circumscribed firm white tumor masses ranging from 5 millimeters to 5 centimeters in diameter. There were nodules on the pleural surface of the diaphragm but there was no evidence of metastasis to the abdominal organs. Microscopically the tumor stroma consisted of delicate fibrous tissues in the meshes of which were very large clumps of epithelial cells with some denomateous arrangement and which showed considerable variations in staining qualities. The cells for the most part were rounded and varied very slightly in size. There was no mucous formation in the growth.

Diagnosis: mediastinary adenocarcinoma.

**CASE 3.** Squamous cell carcinoma of the lower third of the esophagus with extensive metastasis above and below the diaphragm and to the upper portion of the right humerus.

A colored man aged 49 years, 8 months before death began to complain of weak spells and pain in the epigastrium. This pain was irregular in its occurrence and as severe enough to keep him awake at night but was relieved by sodium bicarbonate until the past 3 months. He was nauseated frequently but did not vomit. He also complained of severe aching pain in his right shoulder for 2 months.

X-ray showed obstruction of the esophagus at the eighth thoracic vertebra and a neoplastic growth which had deformed the neck of the humerus. The Wassermann test was negative.

At autopsy (I G H No. 694) the esophagus was found to be the seat of a large ulcerative mass involving its lower portion for a distance of 5 centimeters. The process had not extended through the wall of the organ but had extended into the cardiac

end of the stomach giving rise to an ulcer 2 centimeters in diameter. The edges of the ulcer in the stomach were raised and indurated and its base presented an irregular and indurated surface. The esophagus above the ulcerating mass presented several firm and small elevated areas beneath and covered by the mucosa. The cancer extended through the middle third and on section were of the same character as the mass below. At the bifurcation of the trachea the lymph nodes were enlarged and were replaced by tumor tissue. The esophagus was adherent to the trachea just above its bifurcation and at this position the growth had infiltrated into the mucosa of the latter but had not perforated through.

Similar tumor nodules as large as 1 centimeter in diameter were scattered throughout both lungs. The lymph glands at the hila were involved. Both adrenals were replaced by the tumor and both kidneys contained numerous hard white nodules 1 to 2 centimeters in diameter. The liver was studded with tumor nodules and the mesenteric lymph nodes were matted together and replaced by the tumor tissue. The neck of the humerus was destroyed by a similar tumor growth. Microscopic sections showed the tumor tissue in each of these organs to be a typical prickly cell carcinoma. Broder's classification grade 4.

#### THE EXTENT AND DIRECTION OF THE METASTASES ACCORDING TO THE POSITION OF THE LESIONS IN THE ESOPHAGUS

The middle third was most frequently the seat of the primary lesion and the center of the lesion was most commonly above the area of constriction where the esophagus is crossed by the left bronchus. In the lower third the lesions appeared to have originated usually about the area of constriction where the esophagus passes through the diaphragm. We could not be sure in the larger local growths that these two areas of constriction were the points where the growths began. In many of the smaller lesions we could be more positive that they did begin at the areas of normal anatomical constriction (Table I).

TABLE I—SITES OF THE ESOPHAGEAL CANCERS

	C
Upper third	4
Middle third	19
Middle and lower thirds	4
Lower third	14

*Upper third.* Of the four growths occurring in the upper third one involved the esophagus for a length of 5 centimeters and gave rise to

no metastases. The cancer was of the prickly cell variety grade 2, and the patient's symptoms were of only 6 weeks' duration. He died following a gastrectomy.

The three other growths gave rise to extensive metastases in the chest similar to but not so marked as the second case described in the preceding pages. Two of these lesions perforated into the trachea and in only one did metastases occur below the diaphragm and this was only one small nodule in the liver. In the cases that metastasized the lymph glands of the neck and superior mediastinal glands were more extensively involved than the posterior mediastinal glands (Table II).

*Middle third.* Of the nineteen cancers occurring in the middle third six did not give rise to any metastases. In five of the remaining cases there were no metastases below the diaphragm while in three of these metastases were extensive above the diaphragm. There were no cases that metastasized below the diaphragm that did not also metastasize above it which will be seen to be different from the lower third growths.

Eight of the middle third cancers gave rise to extensive metastases above the diaphragm, two of which also extended to the abdominal organs involving the liver, most of the lymph glands, both kidneys and adrenals. In one of the eight the only metastasis below the diaphragm was a small nodule in the right kidney. Another showed the only metastasis below the diaphragm to be in the scrotum and to involve the testicle. The other cases in which metastases occurred below the diaphragm only the lymph glands at the fundus or along the lesser curvature of the stomach were involved.

The posterior mediastinal glands and peribronchial glands which are shown in the photograph were the first to become involved and when any metastases occurred they were always involved. Many cases showed them to be involved when no other structures were and their close proximity to the growth is very evidently the explanation (Table III).

*Middle and lower thirds.* These four cancers involved the middle and lower thirds to such an extent that we were unable to determine in which of them the growth started. With the exception of one they metastasized widely

TABLE II—CANCERS OF UPPER THIRD

Age	Symptoms	Type of	Extent of local	Metastases	
				Above diaphragm	Below diaphragm
M 5444 6	Loss of weight t gth yr P l h t wk	Adenocarcinoma lly ty	Extensive l g d m t m l d th l m t oc	4 t p m d t d E t p m d t d B th l g	N
M 6 5	Cough blood l f m g	Squamous t m l l g d 3	Mas bstru t g gu t t ach	C M k d d pos l d pe l f od T h l g f	A l gl l l od
M 9 3 73	Cough th blood t s wk	Papillary kl l l g d	Adenocarcinoma s m l t l C t t d h m l g h g b s t	N d l b y d m b os d	N
M 6745 7	Cough l f t l d l l m g 4	Papillary kl l l g d 3	Extensive Fl t l t l by 3 m pe l l h t b t oc pb g	L g d m t m g l l l t d m f t l d	N

above the diaphragm and in two instances both lungs were studded with cancerous nodules. Two of them gave rise to extensive metastases below the diaphragm and involved the liver, kidneys, adrenals, and lymph glands.

In the other two the metastases below the diaphragm were present only in the glands at the fundus of the stomach and along the lesser curvature.

One of the four cases metastasized to the coeliac glands without any metastases above the diaphragm (Table IV).

*Lower third.* Of the fourteen cancers involving this portion of the oesophagus there were three which did not metastasize. One metastasized extensively above without any below the diaphragm.

In 9 cases metastases occurred below the diaphragm and in there were no metastases above. Five of the 9 extended extensively throughout most of the abdominal organs and 3 of them also metastasized to a fairly marked degree above the diaphragm.

The lower third cancers therefore gave rise to the highest number of extensive metastases below the diaphragm. Of the cancers that metastasized there was only one which did not involve the abdominal organs. This is because of the close communication between the lymphatics of the lower third of the oesophagus and the coeliac nodes of the abdomen.

#### THE RELATION OF THE DEGREE OF MALIGNANCY TO THE EXTENT OF METASTASES AND DURATION OF LIFE AFTER ONSET OF SYMPTOMS

In one instance the cancer was of the adenomatous type arising from the mucous gland in the submucosa. It was of the basal cell type and 39 were squamous cell cancers. Twenty-eight of the squamous cell cancers were of the prickly cell variety, while in the remaining 10 there was less differentiation.

In this classification we have used Broder's grading. We believe that there is a great deal of personal variation in the use of this method, but that with experience one can in the majority of instances agree with his fellow pathologists.

In cases on which we differed the degree was slight and the average should be fairly accurate. The Broder's grade was determined while we were still in ignorance of the clinical course and metastases.

*Grade 4-9 cases.* The average duration of life after the onset of the first symptoms was 3½ months and all of the cancers gave rise to extensive metastases either above or below the diaphragm or both. In 5 of the 9 the metastases were extensive above and below. Three of these occurred in the middle third and 2 in the lower. In cancer of the lower third metastases occurred extensively below the diaphragm and slightly above it.

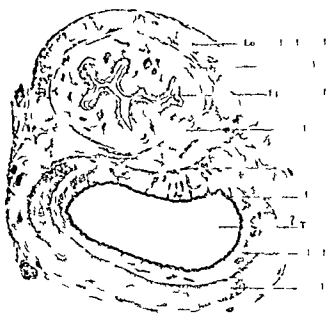


Fig. 1. Transverse section of trachea and esophagus of child seen from below. (From Ellis and Johnston.)

In other case the metastases were extensive above and slight below. One occurred in the upper third and the other in the middle.

**Grade 3-17 cases.** The average duration of life after the first onset of symptoms was 5 months. Extensive metastases occurred in 5 cases, moderate metastases in 2, slight metastases in 3, and no metastases occurred in 2 cases. Of the cases of this group that did not give rise to any metastases, one did not have any complaints referable to his esophagus and the growth was small. The other case had symptoms for only 3½ months and the local lesion involved the esophagus for 7 centimeters. We were in doubt on microscopic study whether we should have called this a grade 2 or 3 prickly cell cancer. Of the cases where only a slight metastasis occurred, one had given rise to symptoms 5 months, another 4 months and the third had not given rise to any symptom, and in 2 of them the local lesions were small.

Of the cases in which metastases were moderate, one gave symptoms 3 months and the other 4 months. The first cancer locally was small but the second involved the esophagus for 10 centimeters.

**Grade 2-15 cases.** The average duration of life after the onset of symptoms was 8 months and 7 days. Extensive metastases occurred in

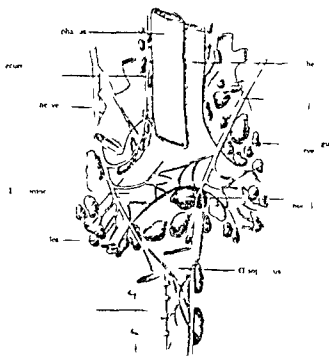


Fig. 2. Tracheal and bronchial lymph node viewed from behind. (From Ellis and Johnston.)

5, moderate metastases occurred in 4, slight in 1, and no metastases in 5. Of the cases giving rise to extensive metastases the shortest duration of symptoms was 6 months and the longest duration of symptoms was 10 months. The average duration was about 8 months. In all of the cases the local growths were large and involved the esophagus for an average length of 1 centimeter.

Where the metastases were moderate the longest duration of symptoms was 2 months and the shortest was 4½ months. The local growths were large and involved the esophagus for an average length of 8 centimeters. The case which had only very slight metastases in the immediate esophageal lymph glands had complained for 11½ months and the local lesion was 4½ centimeters long. The shortest duration of symptoms in the cases in which no metastases occurred was 1½ months, the longest was 15 months and the average was 7 months. The local lesions in these cases were smaller than the others but averaged 6 centimeters in length, the largest being 10 centimeters.

**Grade 1-3 cases.** There were only 3 cases of this type and the average duration of life was 16 months. One of these had had

TABLE III—CANCERS OF MIDDLE THIRD

S	Ag	Symptom	Type	F	t	f	l	l	M		t	t
M	67 6	D i f b l h e m h f l h h i h a	P k l l i g d s	m l l i t t t m l l h d	l t L o	d f	S	d h b l f m t t	N			
M	7 0	C h p H f h k m	S m l i g d	F l l 7 f h s m l v r y	L o t t h d p h	d	S m l l o d l k d y					
M	7 8	A k f N l i	P k l l i g d	L l M k l l b s m h h t d l l t d	N		N					
M	5	L f h t d m l f h h s h m h l m	P k l l i g d	F l t l m l t h h	L	E t l m a p o t m l f b f h h l h h l	N					
I	7 6	F l l l l l g k f f h h t k s k	P k l l i g d	O l b f h b h s h	M k d l b m o s a d h h l f l k	l l f f	T b l y p h l i t d d p h f t h					
F	8 8	h l l g k	I k l l l l s	F l t l d l h h g b	M	l f l m d h h l l d m t l l	C l f l e l M d t p m g d l					
M	8	I l d f l l l m	P k l l l d	O b t l m f m s m b e l h f	T	d m m l l y l d l h t	N					
M	8 5	I l g l f f l l g m	q m l i g d	L l g d t m S m l p f y	P f m m m N		N					
M	8 6	F Y l l l h d l l o c l f k	I k l l i g d	L l l d b t m l f	L a g m N d h l f l h b o b l	l h	N					
M	8	D f l l l l b h m D f k	L l l l	O b l h g m s m	N		N					
M	9	D f l l l m P	m l i g d s	O l b m	I t d M l l l f d N o d f h	l	S b y l 7 8 l l m l					
M	5	I l m l l l	P k l l i g d s	O b t l d l m d l	M	h l l l l l m h l	C o l d f m l g h t					
M	7 5	I l l d f l m l	l l l 4	O l t d f l l h f m l h l a k p p a l l b e l	S	l t g m i a s p o m B h l h d f d h h h L b h h m f i l l	L l l l l B h l f l l l f l s h l b d l					
M	8	I h l l l m	I l l l d	F l t l l l h l m d d l h l h d h	N		O l h p e f d l l a z l d d f					
M		N h h f b l	P k l l i g d	F l m l l h 7	P b h l l l l		P p l d					
M	8	I f l l l	I k l l i g d	C l l k m l l l l t	P b h l g l l	L	N					

TABLE III—CANCERS OF MIDDLE THIRD—Continued

S	Age	Symptom	Type	Location	Metastasis	
					Middle lobe	Distal lobe
M	35	Intermittent dysphagia (intermittent)	Papillary	Obstruction with intermittent regurgitation	Negative	Negative
M	67	Dysphagia intermittent	Papillary	Prolapsed regurgitation intermittent	Negative	Negative
M	54	Pain intermittent	Papillary	Malignant regurgitation intermittent	Pain intermittent	Lymphatic metastasis

symptoms for 4 months and the growth had given rise to extensive metastases in the chest and to a few lymph nodes of the celiac chain. The other had caused symptoms for 17 and 7½ months respectively and the local lesions were large but had not given rise to any metastases.

Only one tumor was of the basal cell character and involved the middle third for 8 centimeters but had not caused any metastases. Case 2 described in detail in the preceding pages was a very malignant adenocarcinoma.

#### SUMMARY

Of the 41 cases of esophageal carcinoma comprising this study, metastases occurred below the diaphragm in 22. In 9 of these the metastases were extensive in 11 metastases occurred in the liver in 8 only the glands at the fundus of the stomach and the celiac chain were involved. There were 4 instances in which the metastasis occurred below the diaphragm without any above it and all of the primary growths were fairly large involving only the lower third of the esophagus. In one metastasis occurred in the liver, kidneys, adrenals and lymph glands in the others it was limited to the celiac and mesenteric lymph glands. Metastasis limited above the diaphragm was present in 9 cases and in 4 instances it was extensive. There were 18 cases in which the metastasis occurred both above and below.

Ten of the cancers or about 5 per cent did not show any metastasis but one however, had perforated and had given rise to an

empyema. Two of them were prickly cell cancers grade 1, 5 grade 2, grade 3, and 1 was a basal cell cancer.

As brought out in the preceding pages the cancers of the higher grades that did not give rise to metastases were of a short duration.

#### DISCUSSION

Dr. Chevalier Jackson in a paper on "Why Can Surgeons Not Cure Cancer of the Esophagus?" brought out many interesting points in which he rightfully condemned many of the procedures in the diagnosis of cancer mentioned in surgical textbooks. He states that the esophagoscope and X-ray are the only two methods of procedure to be used and that the lesion can readily be diagnosed with the esophagoscope when it is no larger than an orange seed.

The greatest difficulty with early diagnosis of cancer does unfortunately not depend on our present day methods of procedure but upon the fact that cancers of the esophagus do not cause recognizable symptoms until very late.

The esophagus does not have very sensory nerves for which reason the earliest symptoms are reflex. Substernal discomfort or spasm of the cardiac end of the stomach are the early symptoms in some cases. Most commonly difficulty in swallowing causes the patient to apply for treatment and usually by the time this symptom occurs the lesion is fairly extensive and may or may not be metastasized depending upon the duration.

TABLE III—CANCERS OF MIDDLE THIRD

S	V	ympt m	T pe f	E t t floc ll	M t t	
					Ab d ph gm	Bl d h gm
M	67 6 7	I l f b th m h f N h α h bl h	P kl llg d 3	Sm ll l t l b t l l m ll Lo d d f	S d h t b t l f m t ta	N
M	7 9	C h f pe h k m H	m llg d 1	H t l l l b s m l l l l	Loc l h d or ph	Sm ll d l gh k da y
M	7 5 84	A k f p N l p m	P kl ll d	U l k l l t s m h h d l l t d	N	N
M	5	L f h l l P f h lm y h m h	P kl llg d 1	l l t f l m l th h t	La E t J ma pot m m p f t l f b h d t l t h l g t h h l	N
Γ	7 6	D E l l l d l f l m k C k	P kl llg d 3	Ol t m l b h h s h b f	I l M k l l l f l l h d h f l h l f l a M	Tw lymph d l bel d ph d l f t
Γ	8 8	C h l t d f l ll k	P kl llgr d	Γ d l l l h g m b	M f l m d t h l l od	Coel f od M p s h d de m
M	5 05	I l d Y l l l m	I kl ll d	Ob l g m m s m b l w h f	T d mmed by l d g pe f l h	N
M	8 5	I l d l l l l m	Sq m ll l 3	L l d by m m llpe f y	P f t m y m g se m N	N
M	8	I f l w ll m P h h blood p C h k	P kl ll d	U l l d bst m l f	L g m rr l h h h l b h N d h r pe f b h l	N
M	9 8	I f l l l l h m l k	B l ll	Ob l h m s m	N	N
M		I f l l l m P	ll d 3	Ol l l h by m	P t l M l l l f Nod f h b	S b l 7 8 l l l
M	5	I d l m ll l l	I kl ll d	Ob t l d l m l l	M h d g H l m h l	Coel d l m l g t
M	7 5 8	I ll l l y m Γ m	S m llg d 4	Ol d f l m l h L k f m l h L k pp ll y bet l	L l g m d m B h l h I h b h m fill t	L tr l l d B b l l k d y l h h l b l m m h l d l l m h l d l
M	5	D Y l l l f m N m	P kl llg d	Γ l l m l l w h h rr t th m	N	O l h pe f d h h d d f
M		N h h bl	I kl llg d 4	Fl m l l th l	P b h l l l s	P po gl h
M	8	I l l ll	I kl llg d	C l k m l y t l b t	P b h l l l ds	N

TABLE III—CANCERS OF MIDDLE THIRD—Continued

Case	Age	Symptoms	Type of cancer	Extent of local	Metastasis	
					Abdominal	Bilateral
M 355	43	I H G L t m C t m y 5 m	P k l l g d s	Ext t g m th 5 l f at l t t	Nec t l h t N t f l th	N
M 6854	67	D f l t k b e f m m	P k l l g t l	P t l t t t g f g t g l l t t g 5 m l k h	N	N
M 9592	54	I m l f t m y l l m g j l m t g	P k l c l l g r l s	M m l l t p r e t p t f g t t h k l f e s p h g u o s a t b k	Postm l t m o l d l e s t t t g t h g h b o t h l g	L m s t d l l L g t k l y c t B t h m o l l e s M u t l r e l c l y m p h g l j

symptoms for 24 months and the growth had given rise to extensive metastases in the chest and to a few lymph nodes of the coeliac chain. The other had caused symptoms for 17 and 7½ months respectively and the local lesions were large but had not given rise to any metastases.

Only one tumor was of the basal cell character and involved the middle third for 8 centimeters but had not caused any metastases. Case 2 described in detail in the preceding pages was a very malignant adenocarcinoma.

## SUMMARY

Of the 41 cases of esophageal carcinoma comprising this study metastases occurred below the diaphragm in 22. In 9 of these the metastases were extensive in 11 metastases occurred in the liver in 8 only the glands in the fundus of the stomach and the coeliac chain were involved. There were 4 instances in which the metastasis occurred below the diaphragm without any above it and all of the primary growths were fairly large involving only the lower third of the esophagus. In one metastasis occurred in the liver kidneys adrenals and lymph glands in the others it was limited to the coeliac and mesenteric lymph glands. Metastasis limited above the diaphragm was present in 9 cases and in 4 instances it was extensive. There were 18 cases in which the metastasis occurred both above and below.

Ten of the cancers or about 25 per cent did not show any metastasis but one however had perforated and had given rise to an

empyema. Two of them were prickly cell cancers grade 1, 3 grade 2, 2 grade 3 and 1 was a basal cell cancer.

As brought out in the preceding pages the cancers of the higher grades that did not give rise to metastases were of a short duration.

## DISCUSSION

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TABLE III.—CANCERS OF MIDDLE THIRD

S	Age	Symptom	Type	E	F	M t	
						Ab	B l
M 6736	97	D 1 f t h m y h f b l h th æ ph	P kl llg d 3	Sm ll l t t t m ll Lo h d l f	S d t t b t t t h f m t t	N	
M 7 9	55	C h f h 6 m H f k	m llg l	Fl t l h y 5 m t l v y l l l	Lo l t d cresoph g h d	m ll d l g h k d n y	
M 7	8	A k f p N d f	P kl llg d	U l k i l b 5 m h t l d l d	N	N	
M 7 57	5	Lo f h i m l f h h m y h m h	P kl llg d	l l l h l m l h m h t	L E d m m p e f h g l f b h h l t t h h l	N	
I 3		I f l l h m k l f h h m t k 8 k	P kl llg d 3	Ob t l v r h l b f h b f	I f k i l l f f t b h m l f b h M t h l f l	T lymph od l b l d l f m h	
F 8	8	( h l l i l k ll	P kl llg d	F d l t t h m g b	M d f l m d m l h t l d d	Coel f l l M d p m d	
M 8		I l d m l l l	I kl ll d	Ol l g m o m s m bel h f	T l m m d t l l l p h	N	
M 8 8	6	I l d f l l l m	Sq m llg d 3	U l d b m t m ll p e f y	P f m p m m Asta	N	
M 8		I f l l l l m m P m l h b l o s l p m	I kl ll d	U l l f b t m l f 9 m	L g m l b l h t h l f l h N d h l g	N	
M 8		I h l l l l b l m l J k	B l ll	l l h m 8 m l l	N	N	
M 9		I f l l p ll m m s	m ll d 3	Ol t l l l by m g h	P t M d t t l od N f h b	S by l s l l l	
M		f l l l y ll l d	I kl ll d	Ol l d l m d l	M h m d t H l m h l g	Coel d g l l l M d g e c t l l	
M 7 3		I l l d l l y f d	m llg d	Ob d f t l m l h La k f m l h La k p e d i y be l	I l m t m l pos m B h l h dd d t h L h b h m f l l d	L t l d l B h l f k d y P N m s h b d n a l l y m h g l d	
M		I f l l l m f m t	I kl ll d	l l l l l f h l m l l b l m h	N	O l h p e f d l l l d f d f	
M 5		N h l l l	P kl llg d	Fl t l l l b m l	P b h l l d s	P p a g l l	
M		I l l l ll l	I kl llgr d	C l k l v y l l m t	P b h l l d s	N	

TABLE V—CANCERS OF THE LOWER THIRD

S	A	Symptom	Type	I t t f l l n	M t t	
					Abn l r h g m	B l l r h m
M	5974	Lo f ght o m P m D f l t s l l ng o m	P kl llg l	U l t g l e s l t l t p l g t m ch t t h t m	I -as ph g l g l n l	U l s t s t m 7 m l m t t t m h l ( f t g t l l m o d l l t t l
M	648	k g g l t t f l t l o d l s m Last	I kl llg l	Obstru t g l l t g g th l l f h g t l l g t g a t m g	N	N
M	694	W k pell t p p g t m s m	Sq m llg l 4	I l t l t l t l l s m f t l l f l m l t f l t h t b m s l D l t t bo l	Lo t m l t l d l h l t t l n l l l g	U l t h L t l l t m h l t l l C l l m t l l l m o d l m k f
M	735	I l g s f l c l t l g t t R g l	I kl llh l	Obst t g l t g l t l g t s m t m h m	N	N
M	747	B l h g s m D C l t w l l g s m R g g t t	I kl llg l 3	U l e t t l p l l t t f 7 m	N	N
M	7384	I l f c l t l h a m s m N m th h g f m th	P kle llg l 3	I t l t t t n u f l t ul t m d y m b y	M s m l m t h l l o t m t t l g l t	B h g l e s e t m h m h g t h
M	799	D f l t l l g m l 4 m p b t m	I kl llg d t	I r t l l t t g l l s m l t l l t h l g t m h t t t	N	G t l p e p l at l y m p h g l
M	8496	L t f ght l l t h l l b k 7 m	Sq m llg d 4	I r t l t t t g l l t t l 4 7 m	U l r h g l l e	F t l t t p e t o l l t
M	866	M k d k 3 m	I kl llg l 4	I l t u l t l m l g t h 7	E m p y m f a r j h g	M t t p e r p l o d l t t t l
M	889	D f l t l l g d l m t g h l t g	I kl llg d 3	Ob t u t g m f l m m	O c l l o d l ch l h	N o d l g l t m h O c l o d l
M	993	R g t t s l m l m H a m h g 3 o c a s	P kl llg d 3 4	P t l b t t g l t f 4 m	P b h l g l d s	G l f t f d f t m h
M	7454	W l l t f 4 m D f l m l l g	P kl c llg d	P t l b t t g l t 8 m	M h l h t g t g l g l l l b h l	G t l l y m p h t g l l l g l r v t e
M	7579	D f l t l l g 8 l m t d b l j	Sq m llg l 3	I g t h l t c t h t d 8 t h m f t m h m	N	L y m p h n d l g l t m h t l
M	547	P b t p t m A b t f f o o d d h m t o f f i l l l	Sq m llg d 3	U l t g d p t l b o t t g l 7	M l a s t l d d d l f l l b e l f t	L t d d d B t h l l m t p l d

can be determined to a fairly accurate extent with the microscope. The position in which the cancer occurs in the esophagus does not have any relation to the extent of metastasis but does have some relation to the direction of metastasis.

Cancers of the upper third metastasize to the glands in the superior mediastinum or deep cervical glands. Those of the middle third most commonly involve the lymph glands around the bifurcation of the trachea. They metastasize below the diaphragm less

TABLE IV—CANCERS OF MIDDLE AND LOWER THIRDS

S	A	S y p m	I f	I t f l l	M t t	
					A b d p h g m	E l d p h
M	5	B l h l 7 m l th l	I k l l l l	U l t m l f l	M h l P t th m	L r h l l l
		l l m		l h l g f l y	l m l f l o d H	l h
M	7	I h l l h	P k l l l l	U l t m l f l	I f l m l p e m l	M 7 fl
		f ( ) m h		m E l m f l th	h l m l f l f	py l h d s f
				m f t m h	O l m D l f	l e s t d g e h
M	8	l f l l th l m	I k l l l d	U l f l f m	N	M 6 d
				m h P t l b		l f f l h
M	8	N h l f b l m	m l l l	A l l f m l l l	P b m h l g l d	C l g l d s l
				l l h d m l l l	l h m g h M l l l	l l d l g
					l h m h l f	6 Left k d n y

malignancy of the individual growth. The œsophagus is an easily dilatable tube and a fairly large growth may permit the food to pass without causing any complaints for the growth most commonly are of the flat ulcerative type. Most commonly the patient does not seek advice until the growth has increased to such a size that it produces some difficulty in swallowing and in many of our cases the patients had lost a great deal of weight and already had widespread metastases before any signs referable to their œsophagus occurred.

For the above reasons a physician should not make a diagnosis of gastric neurosis, nervous spasm of the cardia of the stomach and so forth without first having ruled out cancer of the œsophagus especially if the patient is any way close to the cancer age. Any indefinite complaints in the chest or upper abdomen should cause one to search for cancer of the œsophagus.

#### CONCLUSIONS

Cancer of the œsophagus forms a little more than 5 per cent of all cancer. It is a lesion that occurs for the most part in males. In this series of 41 cases 39 (95.15 per cent) were men. It occurs most commonly in late life and the average age in our series was 60.1 years.

Symptoms occur very late the average duration of life after the onset of the first

symptoms being about 7 months. The most common symptom causing the patient to seek medical aid is difficulty in swallowing while dysphagia in its true meaning painful swallowing is very common.

About 75 per cent of cancers of the œsophagus metastasize and the cause of death most commonly is an intercurrent bronchopneumonia. The lesion occurs most commonly at the level of the bifurcation of the trachea at the point where the œsophagus is crossed by the left bronchus (18 of this series). The second most frequent position is about the point where the œsophagus passes through the diaphragm (15 of this series). These are the points where normal anatomical constrictions of the œsophagus are most marked except at its very beginning.

There is no relation between the duration of symptom or the size of the local lesion and the extent of metastasis for some of the smallest lesions give rise to extensive metastasis while on the other hand some of the most extensive local lesions give rise to very little and some to no metastasis.

The depth of the œsophageal wall involvement does not have any relation to distant metastasis but does to local extension. The most important factor with the duration of life and the extent of metastasis is the degree of malignancy of the individual growth which

Ligation of the external carotid artery was carried out above the origin of the lingual artery. Convalescence was smooth and uneventful.

**CASE 3** Stab wound of the right common carotid artery and the internal jugular vein.

Patient was a colored female age 4 years. Following a marital altercation patient received a knife thrust in the right side of her neck, inflicted by her gentleman friend. Examination showed that the knife blade was embedded to its very hilt in the right side of the neck. The site of the stab thrust was about 2 inches cephalic to the middle of the clavicle. Fortunately no attempt was made to remove the embedded weapon before the patient was sent to the hospital. At operation an incision was made in the neck along the anterior border of the sternomastoid muscle above and below the embedded blade. On withdrawing the embedded blade from the neck a most alarming gush of blood ensued. The common carotid and internal jugular vein were rapidly ligated *en masse*. The necessity was for rapid and immediate control of the hemorrhage. Whether the vagus nerve was included in the ligature cannot be stated. The patient suffered no immediate or later ill effects from the ligation for she made a complete recovery.

**CASE 4** Rupture of the left axillary artery following the reduction of a dislocated shoulder (reported through the courtesy of Dr. I. H. McCarthy).

Patient was a male age 6 years. Following the reduction of a subcoracoid dislocation of the shoulder a definite swelling appeared in the left axilla which gradually increased in size. The patient became pale and short of breath. The radial pulse on the affected side was not palpable. A wound of the axillary artery was suspected and operation was carried out 12 hours after the time of the reduction. An incision was made in the axilla and the subscapular artery was found torn away from its point of origin from the axillary. Ligation of the axillary artery was performed above the origin of the subscapular. The patient died in 36 hours. Autopsy showed a complete severance of the subscapular artery as it arises from the axillary artery.

**CASE 5** Wound of the brachial artery associated with a compound comminuted fracture of the humerus.

Patient was a male age 30 months. Injury was sustained by patient being hit with an automobile truck. On admission to hospital patient was in profound shock and the entire left extremity was almost avulsed. Shock treatment was instituted. Debridement of the wound was performed and fracture fragments were placed in fair alignment. The brachial artery was ruptured about 5 centimeters above the bend of the elbow. The latter vessel was ligated. Convalescence was stormy. Some infection occurred in the wound but the circulation in the extremity at no time appeared impaired. On discharge from the hospital 10 weeks after the accident the functional result was about 60 per cent. The humerus was well united and the circulation in the injured extremity presented no impairment.

**CASE 6** Stab wound of the external iliac artery.



Fig. 1 The popliteal fossa illustrating the proximal and distal fixation of the popliteal vessels. An anomalous tendon here seen which has its origin from the short head of a biceps muscle and inserts in a fan shape fashion on the posterior medial aspect of the capsule of the knee joint. The latter muscle acts as an additional fixation agent.

Patient was a female age 20 years. She was first seen about 30 minutes after the occurrence of the accident. She was pulseless, practically exsanguinated and unconscious.

There was a small innocent stab wound present about 1 centimeter medial to the left anterosuperior spine. This wound was the result of a stab thrust effected by the blade of a long stiletto. It was impossible to account for the sudden and complete collapse of the patient except upon the basis of an injury to one of the larger arterial or venous trunks. Shock therapy was immediately instituted. At the same time under local anesthesia a rapid exploratory exposure of the iliac vessels was carried out. The entire retroperitoneal space was occupied by a massive hemorrhagic extravasation. On removal of the extravasated hemorrhage the external iliac artery 1 centimeter below its origin from the common iliac was found severed for about 2 of

commonly and less extensively than do those involving the lower third. Cancers of the lower third most commonly metastasize below the diaphragm and thus is through the œliac chain.

The surgeon roentgenologist œsophagoscopist and pathologist working together should be able to tell from the degree of malignancy of the biopsy gross description and individual character of a case whether metas-

tasis has likely occurred and if it would be worth while to subject the patient to an operation of high mortality such as resection of œsophagus. It seems unlikely that radical resection will have any place in the treatment of these cancers for the wall is involved deeply in most instances if the cancer cells are not completely picked out perforation would occur and the patient would die of empyema or some chest complication.

## INJURIES OF THE LARGE ARTERIES

### ENCOUNTERED IN CIVIL PRACTICE<sup>1</sup>

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**I**NJURIES of the larger trunks of the blood vascular tree constitute but a small percentage of the accidents encountered in civil practice. While numerous statistics based on experiences gained in the recent and past wars are present concerning wounds of the blood vessels injuries of the blood vascular tree in civil practice are usually not the result of gunshot wounds. But what chiefly distinguishes civil vascular injuries from those observed during war is their difference in etiology and in the mechanism of their production. Not included in this study are the injuries of large vascular trunks inadvertently inflicted during the course of an operation for such wounds are under the direct control of the surgeon.

The present study is based upon 9 cases due to a variety of causes: explosion of overcharged seltzer bottles, fracture dislocation of the jaw, contusion without associated bone injury.

**CASE I.** Penetrating wound of right common carotid artery, right pleural cavity and apex of right lung.

Patient, a female, age 35 years. The injury followed the spontaneous explosion of an overcharged completely filled seltzer bottle. The bursting of the glass container occurred in the attempt to express some of the carbonized fluid from the bottle into a drinking glass. A shrapnel of thin glass forced

under high pressure immediately flew in the direction of a number of fragments penetrated the right side of patient's neck and supraclavicular fossa. A small wound as present about 1.5 cm. below the thyroid cartilage medial to the anterior border of the sternomastoid muscle. Three additional wounds were also present in the supraclavicular fossa.

The patient was pulseless when she was brought to the operating room. An incision was made at the anterior border of the sternomastoid muscle. The common carotid artery was wounded for more than one third of its circumference which was wound as sutured the circulation in the artery being controlled during the suturing by tapes above and below the vascular wound. Pulsation was present in the vessel at the end of the operation. The pulse rate continued high 120 to 130 and the patient became enfeebled and apathetic. Death occurred on the fourth day. At autopsy the lumen of the injured vessel was filled with a large deformed thrombus being in line with the suture and extending proximally for more than 2 centimeters.

**CASE II.** Penetrating wound of the left external carotid artery.

Patient was a male, age 22 years. The accident occurred in a manner similar to that in Case I, the injury being the direct result of the spontaneous explosion of an overcharged seltzer bottle. The oblique gaping wound of about 5 centimeters in extent extending medially and caudally from the angle of the mandible. The injured area was occupied by a large clot acting as a tamponade. The clotted blood was evacuated and the external carotid artery exposed. The external carotid artery between the origin of the facial and lingual arteries was secured for about one half of its circumference.

<sup>1</sup> T. M. H. D. I. P. H. J. T. A. M. F. H. J. F. N. d. I. C. H. d. H. g. l. S. e. f. H. M. S. H. I. F. J. d. R. d. b. e. f. t. h. J. F. S. x. y. f. C. l. u. n. I. I. F. b. y. 6. 7.

In most of the reported cases the carotid ligation was carried out for a pulsating exophthalmus or aneurism of the carotid artery or as a preliminary measure in operation for malignancy of the head and neck so that much of the available information concerning the effects and dangers of carotid ligations is based on this data. The possible development of encephalomalacia with a resulting hemiplegia is always an impending danger in the ligation of the carotid artery. Sattler in 17 ligations for pulsating exophthalmus notes 17 fatalities upon the completion of the ligation.

In rabbits ligation of one common carotid artery produces no noticeable effect on the animal. In a number of instances both common carotid arteries were ligated and the result was always fatal. In man the incidence of encephalomalacia depends upon a number of factors: first the general state and age of the patient; second the presence or absence of changes in the vessel walls—it was a teaching of Kocher that to tie the common carotid artery in a person past middle life was always dangerous and in the arteriosclerotic equivalent to a death warrant—third the manner of application of the ligature; fourth the variations in the vessels forming the circle of Willis. Concerning the last the observation of a large number of brains in the neuro-anatomy laboratories of the Jefferson Medical College discloses the fact that variations in the circle of Willis are a rather common finding. Particularly significant is the presence of an exceedingly small posterior communicating artery or complete absence of the latter vessel. Such anatomical variants undoubtedly affect the outcome of some cases.

Many of the carotid ligations cause no disturbance. Occasionally the evidence of cerebral disturbances does not appear for some hours or days after the application of the ligature.

The opinion has been expressed by a number of able observers notably Perthes (21, 2) that the cerebral disturbances following carotid ligations are due to thrombus formation and resulting emboli. The relation of thrombus formation to a sudden and forcibly applied ligature has been noted particularly by

Sigrist. In an analysis of 80 fatalities following ligation of the common carotid artery he noted an ascending thrombus extending toward the head from the site of ligation 4 times. The thrombus formation was the direct result of a sudden and forcibly applied ligature.

John Hunter was first to call attention to the importance of avoiding injury to the vessel walls in the application of a ligature.

The contusion of a large vessel causes definite slowing of the circulation even though the vessel is uninjured. Probably the vascular contraction noted in the operation of arterial sympathectomy can be interpreted in the same way. The vessel narrows for a time. The narrowing causes an increased resistance to the circulation because of the narrowing of the lumen of the artery while the arterial pressure centrally remains unchanged. Injury to the vessel wall particularly the intima and slowing of the circulation are among the chief causes of thrombus formation. If the blood stream flows with its accustomed force it may tear a small thrombus from the site of vessel injury and the beginning thrombus would then form an embolus. Or the thrombus may grow into one of the adjacent collaterals and interfere with the developing collateral circulation or may form another embolus. In brief traumatism of the vessel and a change in velocity of the blood stream may be directly responsible for the formation of a thrombus and possible emboli.

The application of a ligature to large vascular trunks must be slow and gentle either fascia or a thick coarse thread being used as tape. In this way one tends to eliminate injury to the intima one of the chief causes of intravascular clotting. In the young with soft elastic walls it is possible to occlude the lumen of the vessel without injury to the intima but in the sclerotic vessel with its friable intima it is almost impossible to ligate an artery without intimal trauma. This latter fact represents the great danger of carotid ligation in the old.

Secondary hemorrhage can as a rule be prevented as noted by Blair (1) in heeding the advice of Billroth neither to suture any wound in the floor of the mouth nor to suture

its circumference. No other vessel trauma as present. The wound in the artery was sutured and the circulation above the site of injury as controlled by tapes. When the suturing was finished palpation of the vessel below the site of suture was easily visible. Within 48 hours definite evidence of arterial occlusion appeared. The dorsum of foot below the malleoli showing signs of gangrene. A line of demarcation was present in 4 days. On the sixth day after the occurrence of the injury amputation was performed about centimeters above the line of demarcation. The tissues were anemic pale gray and did not bleed. Five days later a revision of the amputation stump was carried out. The tissue now bled freely, the muscles were red and full of life. A collateral circulation had established itself within the 3 week period.

The patient at the present time has a useful eight learning stump extending 8 inches below the tubercle of the tibia, capable of performing all of her household duties with relatively little discomfort. Her general health is excellent.

**CASE 7.** Wound of right femoral artery and vein the result of a compound comminuted fracture of the upper third of the femur.

Patient a male age 36, a truck driver as thrown off his truck and sustained a massive wound of the upper end of the right thigh. On admission to the hospital he had a profound shock and in addition bleeding, as continuous from a massive laceration on the ventral surface of the thigh. Shock treatment assisted little the femoral artery and vein ligated. The upper end of the femur was markedly comminuted. Within an hour after admission in spite of every effort he succumbed.

Autopsy showed a complicated comminuted fracture of the upper third of the femur. The fracture fragments had no connection through the femoral artery and vein.

**CASE 8.** Subcutaneous rupture of the left popliteal artery and vein following the complete mobilization of stiff knee joint.

Patient a female age 34 years as admitted to the hospital for the purpose of bringing up adhesions about the knee joint. The affected articulation was stiff with the normal range of movement present. Clinical and X-ray examination of the joint showed that the limitation of movement was due to periarthritic adhesions and not to bony ankylosis. Under nitrous oxide anesthesia the knee was actively mobilized. Within 12 hours after the mobilization the leg became cold slightly cyanotic and edematous.

No pulsation palpable in either the posterior tibial or peroneal arteries. Pain was absent over the popliteal region. Conservative treatment in the form of heat elevation and immobilization produced no effect and the clinical evidence of gangrene continued to advance. An amputation through the lower third of the femur was carried out 5 days after the initial mobilization of the stiff knee joint. Dissection of the amputated extremity showed a

rupture of the popliteal artery and vein midway between the adductor hiatus and the bifurcation of the popliteal artery into its anterior and posterior arteries.

**CASE 9.** Subcutaneous rupture of the popliteal artery and vein the result of a football tackle.

Patient a male age 18. While playing football he was tackled vigorously and rolled about the right knee and thrown to the ground. Sudden and increasing pain as immediately present in the right popliteal region. He was unable to flex or extend the knee. The popliteal fossa showed a moderate swelling which appeared to be increasing. In a number of hours induration and moderate swelling of the calf were noted. Palpation of the posterior tibial and peroneal arteries could not be palpated. Because of the severe increasing pain a distal anastomosis over the right popliteal area and the induration of the leg per se advised on the basis of a probable vascular injury. Operation was carried out 6 hours after injury. The right popliteal fossa was carefully explored through a long posterior incision. A hematoma of considerable size was present and evacuated. The popliteal artery was almost completely occluded and occupied by small thrombus. The popliteal vein also showed a late arterial tear. The artery was ligated between ligatures instead of a ligation in continuity. The popliteal vein was also ligated. The induration of the calf of the leg was probably the result of so-called anemic induration for there was no hemorrhagic extravasation present in the calf of the leg.

The wound was closed without drainage. On the third postoperative day about 2 ounces of serum were evacuated from the incision. Other complications a smooth and healing was by first intention. He was kept in bed for 21 days. The circulation of the leg good presents no swelling but he has a moderate foot drop which however has not incapacitated him in any way.

#### CAROTID ARTERY

Wounds of the common carotid artery are preferably treated by suture. The nearer the injured vessel is to the heart the less likelihood there is for a suture repair of the vascular wound to be followed by thrombus formation beginning at the suture line. Frequently however the associated trauma permits only the application of a ligature. In the greater proportion of the reported cases of carotid artery wounds ligation of the injured vessel was the usual procedure. Haberer (4, 5, 6) reports 8 cases in which the wound in the common carotid artery was sutured 2 circular and 5 lateral in one case ligation was later made because of secondary hemorrhage. Of the 8 cases 7 recovered and 1 died.

reality a maneuver of active self reduction on the part of the patient and depends essentially upon the premise postulated by Sherrington. No anæsthetic is required, thus the necessity of all manipulative force being reduced. This method of reduction is carried out as follows:

The arm is placed so that the elbow rests against the anterosuperior spine of the ilium. The arm is first raised slightly in the sagittal plane. The patient is instructed to perform external rotation forcibly, the latter movements being aided by the surgeon who at the same time adducts the arm. The simultaneous action of the opposing movements of external rotation and abduction and adduction with internal rotation permits the head of the humerus to slip quickly into the glenoid cavity. There is no audible click on reduction when this technique of reduction is practiced. It is carried out more easily and rapidly than the Kocher and other methods and tends to eliminate the hazard of arterial injury.

In the case of the popliteal artery additional anatomical relations render this vessel more prone to injury from a contusing force. The vessels of the lower extremity particularly in the popliteal space are in more intimate relation to the bone. Figure 1 illustrates the proximal fixation of the popliteal artery and vein at the adductor hiatus where it is firmly fixed by the adductor magnus tendinous arch. Distally these vessels are again fixed by the tendinous arch of the soleus muscle and by the anterior tibial artery as it passes through the interosseous membrane. The anatomical nearness of the popliteal artery to the posterior surface of the femur and its proximal and distal fixations are the latent anatomical factors which explain its subcutaneous vascular rupture the result of a severe contusing injury without an associated bony injury.

Cases 8 and 9 are illustrative instances wherein the popliteal vessels were ruptured yet no bony injury was sustained. The active causes of these 2 popliteal vessel wounds were as follows. Case 8 resulted from active mobilization under anæsthesia of a stiff knee joint. Case 9 resulted from being tackled in a football game. In the majority of instances the suddenness of the applied violence or

movement induces a marked tension and distention of the vessel wall. The elastic tissue of the vessel wall offers but little protection against injury from a sudden violence in the case of the popliteal artery. The maximum distention of the vessel wall may not be reached but the suddenness of the violence ruptures the vessel because of its natural anatomical fixation.

The mechanism of this vascular wound has been aptly compared to a taut string which is held firmly fixed at either end. Should a sudden pressure or pull be applied its center would tend to give away.

Illustrated in Figure 1 is a large anomalous tendon which courses obliquely across the popliteal space. Certainly this tendon when present would act further to fix the popliteal vessels. While the finding of such a tendon is a rare event it must be recognized that the subcutaneous rupture of the popliteal vessels is also a rare occurrence.

Wounds of the popliteal artery which are the result of dislocation of the tibia have been reported in a number of instances. Schulz (5) reports the occurrence of a popliteal rupture in a young adult following the reduction of a dislocation of the tibia. Bruenner (3) reports 4 instances of subcutaneous ruptures of the popliteal artery 3 of which resulted from dislocations of the tibia.

Here again the anatomical fixation of the vessels and the well known fact that when the leg is extended the popliteal vessels do not rest on the bony surface account for a possible rupture of the popliteal vessels if the leg is suddenly overextended as in an anterior dislocation of the tibia.

#### COLLATERAL CIRCULATION

Certainly the establishment of an adequate collateral circulation following the ligation of a large vascular trunk must take some time. In the experimental ligation of large arteries in animals the development of a definite collateral circulation takes from 15 to 21 days depending upon the vessel ligated and the site of the ligation. It is well to remember however that large arterial trunks can be ligated in animals with considerable less fear of gangrene than in man.



without free drainage any wound that contains a ligated carotid or a ligated primary branch of the external carotid. In the ligation of large arteries it is best however scrupulously to avoid drainage.

The prognosis in carotid ligation appears to be more favorable when it is combined with the simultaneous occlusion of the internal jugular vein. In spite of some dissenting opinions concerning the latter procedure, the observations of Oppel, Hager, Torn, Makins (18) and others show that the hazard of arterial ligation is definitely lessened when combined with the simultaneous occlusion of the accompanying vein. Yet Rieder (23) who has had an extensive experience with arterial injuries in 5 cases carried out the simultaneous ligation of the common carotid artery and internal jugular vein and in each instance definite postoperative cerebral softening followed. The ligation of the accompanying vein even though uninjured simultaneously with the wounded artery will be discussed under the general heading of treatment.

#### ANATOMICAL FIXATION OF BLOOD VESSELS

The importance of the anatomical fixation of blood vessels as one of the contributing factors in the causation of vascular injuries following a severe contusing force is deserving of mention. Such anatomical fixations are present at the sites where branches of considerable size take origin. Instances of the latter are the sites of origin of the subscapular and posterior humeral circumflex from the axillary artery and the bifurcation of the popliteal artery into the anterior and posterior tibial.

Clinically this anatomical fact is well illustrated in the type of vascular injury observed incident to the occurrence or to the reduction of a dislocated shoulder. The greater proportion of the available reported cases of axillary artery wounds associated with a dislocated shoulder shows that the type of vascular injury encountered is that either the subscapular or posterior humeral circumflex artery is torn away from its point of origin.

Koerte (10, 11) in 188 reported 2 such accidents in his own experience. In 190 he added another personal case and collected 44 cases from the literature. Of the 44 collected

cases one half of them were in recent dislocations and in more than one third of the latter group the vascular rupture took place during the act of reduction. In only 3 of the entire group was it definitely established that the arterial wound occurred with the dislocation. Furthermore in 6 instances of the 44 the vascular wounds occurred during the reduction of old dislocations. Koerte considered 2 months or more as an arbitrary time division period between recent and old dislocation. Stimson (27) in 188<sub>3</sub> reported 44 axillary artery wounds following dislocation of the shoulder. Of the 44 cases 12 recovered and 3 died.

The noteworthy fact concerning the association of axillary artery wounds with dislocation of the shoulder is that this vascular injury occurs in the majority of instances from the movements and maneuvers usually practiced when a dislocated shoulder is reduced. Excessive violence and excessive traction must be avoided. The presence of arteriosclerosis necessitates extreme care in reduction. It is when the reduction is difficult that a wound of the axillary artery is likely to take place. In the reduction of an old dislocation particular care must be exercised and an open operation is the advisable procedure if the reduction cannot easily be effected. Even the Kocher method of reduction is not without danger in this respect for marked pressure on the axillary vessels is produced in carrying out the Kocher method of reducing a dislocated shoulder.

The prevention of the possible occurrence of this injury merits a brief consideration. Formerly there was a general belief in the importance of the ligaments for the fixation of joints but at present there is a tendency to believe that the tonic activity of muscles is the most important factor. In his series of marvelous experiments Sherrington shows that in ordinary movements muscles obey the law of reciprocal innervation. Antagonistic muscles exert synergistic action and fix the joint.

Iselin (9) has developed a method of reducing a dislocated shoulder which the writer has used in a modified form with uniformly successful and satisfactory results. It is in

vascular trauma present would have seemed to render a fatal issue inevitable yet recovery ensued without an operation. Injuries which involve both the artery and its accompanying vein appear to show a greater tendency to spontaneous cessation of hemorrhage. The spontaneous healing of arterial trunks partially or completely divided has come to light largely by discovery of the vascular lesion in the course of operations upon nerves. Makins remarks that the great majority of these instances are due to contusion. Vascular lesions which are the result of a severe contusion may not effect a complete break in the vessel wall. Herzog (7) in 30 such injuries found the intima alone injured 9 times, the intima and the media 1 times. Sebastian (26) questions whether the spontaneous cessation of hemorrhage occasioned by an injured vessel is not dependent for its cessation upon the equalization and balance of pressure. Thus small vessels bleed less for the pressure is easily balanced. He believes that the bleeding stops spontaneously when the pressure of the extravasated blood in the tissues is as great as the pressure of the blood in the injured vessel. Obviously the contraction of the vessel wall is also a factor. Thus injury of the popliteal femoral or of some other large vascular trunk may temporarily stop bleeding in the absence of an obstructing thrombus.

Should evidence of progressive hemorrhage exist and the hematoma present increase in size operation is indicated without delay. The deliberate delaying of operation in the presence of a large hematoma the result of an injury to one of the large vessels has two hazards: first the pressure of the hematoma on the surrounding vessels which interferes with their participation in the establishment of a collateral circulation—the true causes of gangrene when it occurs after ligation or suture are those which interfere with the establishment of the collateral circulation—second the danger of infection of the hematoma for with infection besides sepsis there is the additional hazard of a secondary hemorrhage. Infection is probably the most frequent cause of secondary hemorrhage.

The danger of hemorrhage following the removal of a retained foreign body deserves

mention. Such a retained foreign body may act as a vascular plug or may control bleeding from an injured vessel by pressure and its removal may set up a most alarming hemorrhage. The surgeon must have this possibility in mind in the removal of a retained foreign body lying in the neighborhood of large vascular trunks and be prepared before and during the operation for such an emergency. Case 3 is an example in this group. The patient a colored female was admitted to the hospital with the blade of a knife embedded in the left side of the neck so that only the handle protruded. Fortunately no attempt was made to withdraw the embedded weapon before the patient was transferred to the operating room. When the knife was withdrawn a most alarming hemorrhage ensued. Both the carotid and jugular vein had been severed. The wounded artery and vein were ligated. Recovery was uneventful.

The question is to whether the injured vessel should be treated by the obliteration ligature or the conservative suture has been admirably summed up by Matas (19). La Roque (14) and others and the consensus of opinion decidedly favors the ligation. The decision in favor of the aseptic ligation is based on the end results that ligation is usually an easy procedure and the suture often a difficult one is entirely outside the question.

In two of the cases included in the series of arterial injuries (external iliac common carotid) repair of the injured artery was carried out by careful suture. In both instances definite thrombus formation resulted extending cephalad from the line of suture. In regard to thrombotic occlusion the experimental evidence shows that even in the best conditions in laboratory animals the suture especially the circular suture is liable to a very considerable percentage of failures through thrombotic occlusion or cicatricial stenosis. Before the war Matas collected from the literature reports of 49 circular sutures which had been performed in civilian hospitals and in peace conditions. A careful analysis of the available postoperative evidence showed that 13.1 per cent had been followed by gangrene. Of the 37 patients who recovered, in no less than 33 (87.6 per cent)

In Case in which the external iliac artery was sutured gangrene of the foot developed probably as the result of thrombus formation at the suture line. An amputation was performed within 4 centimeters of the line of demarcation at which time the muscles were pale dull gray in appearance and the entire procedure was free from bleeding. Three weeks later a revision of the stump was carried out and the appearance of the tissues found markedly changed. The muscles were red glowing with a healthy normal color and bleeding from the cut tissues was most active. The time for the establishment of the collateral circulation in this instance was within the 3 week period.

X ray studies of amputated extremities supplemented by later dissections of the specimens appear to indicate that the arteries accompanying the various nerves are among the most important of the vessels concerned in the formation of an adequate collateral circulation. Experimental ligations of the femoral artery show that the establishment of an efficient collateral circulation following the ligation depends mainly upon the sciatic artery. The vasa nervorum accompanying the various nerves are sometimes vessels of some size and in addition they anastomose freely with other arterial twigs to form a continuous vascular network. When a large vascular trunk is occluded or ligated the vasa nervorum undergo an increase in their lumen establishing an excellent collateral circulation. Variations in the caliber and in the anastomatic arterial network of the vasa nervorum are vital factors in the formation of an efficient collateral circulation.

The pure morphological factor and its relation to the development of a collateral circulation is not sufficiently recognized and has not been given the attention it deserves. While in the main the variations of the larger arterial trunks tend to conform to a number of well defined anatomical types the variations of the smaller arterial twigs are so highly individualistic as to defy analysis. And it is not unlikely that such arterial individualism if means of recording and measuring them were possible would be as distinctive as one's finger prints.

Attention has been particularly focused on the question of pressure exchange of substances in the vessel and vessel walls the tonicity of the capillary bed and tissue need but the pure morphological element is usually overlooked. The marked variations in the blood vascular tree surely must have no little influence in the establishment of an efficient collateral circulation. In a number of studies on the variations of the blood vascular tree (15 16 17) it is noteworthy that a finding of definite hypogenesis of the blood vessel occurs in approximately 8 per cent of all cadavers. This hypogenesis consists of definitely smaller calibered blood vessel and a decrease in the number of branches. The microscopic image confirms the latter finding for the examination of a considerable number of arterial walls shows a wide variation in the general mural structure. The elastic content the muscle content etc exhibit wide variations. In some instances the vessel because of its faulty mural structure appear almost fragile in other cases strong and robust. Such findings are recorded independent of age and disease and represent distinct morphological types.

Conversely considered the presence of additional branches the presence of accessory arteries are not uncommon findings in the experience of any observant anatomist.

Surely such factors as outlined above represent important elements concerned in the formation of an excellent collateral circulation entirely apart from the pure physiological factors. The writer in no way underestimates the physico dynamic factor concerned in the formation of a collateral circulation but desires to call attention to the morphological aspect.

#### TREATMENT

Wounds of the blood vascular tree in which the evidence of hemorrhage is not severe and no continuous increase in size of the hematoma appears may for a time be treated conservatively. Numerous observations are present to show that the spontaneous cessation of hemorrhage is possible in cases of injuries to large vessels. There are a number of remarkable instances on record in which the

vascular trauma present would have seemed to render a fatal issue inevitable yet recovery ensued without an operation. Injuries which involve both the artery and its accompanying vein appear to show a greater tendency to spontaneous cessation of hemorrhage. The spontaneous healing of arterial trunks partially or completely divided has come to light largely by discovery of the vascular lesion in the course of operations upon nerves. Atkins remarks that the great majority of these instances are due to contusion. Vascular lesions which are the result of a severe contusion may not effect a complete break in the vessel wall. Herzog (7) in 30 such injuries found the intima alone injured 9 times, the intima and the media 1 times. Selb (26) questions whether the spontaneous cessation of hemorrhage occasioned by an injured vessel is not dependent for its cessation upon the equalization and balance of pressure. Thus small vessels bleed less for the pressure is easily balanced. He believes that the bleeding stops spontaneously when the pressure of the extravasated blood in the tissues is as great as the pressure of the blood in the injured vessel. Obviously the contraction of the vessel wall is also a factor. Thus injury of the popliteal femoral or of some other large vascular trunk may temporarily stop bleeding in the absence of an obstructing thrombus.

Should evidence of progressive hemorrhage exist and the hematoma present increase in size operation is indicated without delay. The deliberate delaying of operation in the presence of a large hematoma the result of an injury to one of the large vessels has two hazards: first the pressure of the hematoma on the surrounding vessels which interferes with their participation in the establishment of a collateral circulation—the true causes of gangrene when it occurs after ligation or suture are those which interfere with the establishment of the collateral circulation—second the danger of infection of the hematoma for with infection besides sepsis there is the additional hazard of a secondary hemorrhage. Infection is probably the most frequent cause of secondary hemorrhage.

The danger of hemorrhage following the removal of a retained foreign body deserves

mention. Such a retained foreign body may act as a vascular plug or may control bleeding from an injured vessel by pressure and its removal may set up a most alarming hemorrhage. The surgeon must have this possibility in mind in the removal of a retained foreign body lying in the neighborhood of large vascular trunks and be prepared before and during the operation for such an emergency. Case 3 is an example in this group. The patient, a colored female, was admitted to the hospital with the blade of a knife embedded in the left side of the neck so that only the handle protruded. Fortunately no attempt was made to withdraw the embedded weapon before the patient was transferred to the operating room. When the knife was withdrawn a most alarming hemorrhage ensued. Both the carotid and jugular vein had been severed. The wounded artery and vein were ligated. Recovery was uneventful.

The question as to whether the injured vessel should be treated by the obliteration ligature or the conservative suture has been admirably summed up by Mats (19). J. Koque (14) and others and the consensus of opinion decidedly favors the ligation. The decision in favor of the aseptic ligation is based on the end results: that ligation is usually an easy procedure and the suture often a difficult one is entirely outside the question.

In two of the cases included in the series of arterial injuries (external iliac common carotid) repair of the injured artery was carried out by careful suture. In both instances definite thrombus formation resulted extending cephalad from the line of suture. In regard to thrombotic occlusion the experimental evidence shows that even in the best conditions in laboratory animals the suture especially the circular suture is liable to a very considerable percentage of failures through thrombotic occlusion or cicatricial stenosis. Before the war Mats collected from the literature reports of 49 circular sutures which had been performed in civilian hospitals and in peace conditions. A careful analysis of the available postoperative evidence showed that 13.1 per cent had been followed by gangrene. Of the 37 patients who recovered in no less than 33 (87.6 per cent)

by circular suture with and without interposed grafts the anastomoses had proved functionally valueless or superfluous if we are to judge by behavior of peripheral pulses

The margin of the safety must always lie whether with the suture or ligature in the integrity of the collateral circulation. A properly applied ligature suffices to meet almost every pressing indication. From my own small clinical experience ligation (external crural, popliteal, common crural, brachial) has resulted in recovery.

The value and the necessity of ligating the accompanying vein even though uninjured in cases of arterial ligation is variously interpreted. The study of any problem concerning the blood vascular tree must represent a consideration of the circulatory system in total perspective as a closed hemodynamic apparatus subject to potential variations and oscillations. Many believe that the danger of arterial ligation is greatly decreased by the simultaneous ligation of the accompanying vein. The clinical experience of Makins, Oppel, Hager, Torn, Neuhof and St. John (20) and Holman and the experimental analysis of this problem by Brooks ( ) and Holman (8) show a decided decrease in the incidence of gangrene when the artery and vein are simultaneously occluded. In two of the included case reports both the artery and vein were ligated (popliteal and common crural) and the recovery was without note in each instance. Holman advises the ligation of common femoral vein above the deep femoral or even long saphenous in ligation of the popliteal artery in order under certain circumstances to increase the capillary resistance in the thigh and by directing the force of the collateral circulation into the anastomotic channels to lessen the possibility of gangrene. Ligation of the vein nearer the heart is recommended after ligation of popliteal artery and vein if gangrene is suspected but it must be performed before true gangrene supervenes.

Makins believes that the combined procedure maintain within the limb the smaller amount of blood supplied by the collateral circulation. Whatever may be the factors that determine the formation of an efficient collateral circulation surely pressure must be

an important one for change of pressure interferes in some degree with the necessary stimulus for vascular dilatation and exchange of substances through the capillary wall. Blood is serviceable to the tissues in the capillary region only and there is a definite relation between blood pressure and permeability. Furthermore in the examination of capillary fields there is a distinct difference between arterioles and capillaries. Between the capillaries and venules the difference is much less pronounced. The muscular walls of many venules is so thin and incomplete that the exchange of substances through their walls must be considerable and in some cases the vessels which are classed as veins are from a physiological point of view to be regarded as capillaries. Simultaneous ligation of the artery and vein would seem to maintain a more equable pressure equilibrium in the important functioning capillary bed. While the caliber of the capillaries is mainly determined by their own tonus it is of course also affected to a certain degree by the blood pressure (Krogh 13). In some experimental studies concerning the value of the combined procedure Krampf (12) of Sauerbruch's clinic advises against the ligation of the vein. He used the kidney as the basis of his work but his results are by no means convincing. The fact that the arteries and capillaries in normal subjects vary greatly and the fact that the power to resist an internal pressure developed to a different degree in the capillaries of different tissues are entirely overlooked. Without an attempt to saddle this is too heavily with this phase of vascular surgery the balance of opinion both clinical and experimental strongly favors the simultaneous ligation of the artery and vein. The only contra-indication to the ligation of the vein as noted by Brooks is evidence of obstruction in the collateral veins.

The operation in cases of arterial wound necessitates a generous exposure of the injured vessel. Every effort must be made to conduct the operation aseptically in order to eliminate the hazard of thrombosis and infection. Drainage in vascular surgery must be scrupulously avoided. Packing and drainage as Holman notes invite disaster. The ligature

must be applied gently to occlude the lumen of the vessel without intimal injury. Studies by Schaeffer (4) at the Brough Institute of Anatomy on the obliteration of the lumen of blood vessels indicate that injury to the endothelium incident to ligation may result in intravascular clotting and thrombus. In one series of ligations thrombosis was of common occurrence while in a second series it was rare. Halsted, Holman and others advise the use of coarse ligatures such as tape rather than fine ligatures which may cut through the arterial wall. This has been our practice. In the one popliteal ligation the artery and vein were divided between ligatures instead of ligating in continuity. Holman has again directed attention to the value when feasible of dividing the vessel between two ligatures. He considers this procedure preferable to ligation in continuity.

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TABLE I—THE EFFECT OF CHLOROFORM AND ETHER ANESTHETICS ON THE CARDIAC OUTPUT AND BLOOD TISSUE

Dt	Wght kgm	P lse pe m	T m pe l	A t O A l pe	A O A l pe	A A D f pe	O C pe	C t t pe m	O t p t pe cm	O t p t pe cm	A t p t pe cm	A t p t pe cm
3 p m t l t dy	3.6	60	98.6	8.84	48	6.30	89	1157	3	5		
3.55 p m ft hl f m	3.6	5	98.6	8.84	0	6.48	86.4	333	69	7		
4.5 p m ft hl f	3.6	55	98.6	9.56	6	7.9	8.8	45	77	0		
5 p m t l t dy	3.6	7	99	8.4	8	5	86.4	8				
5.55 p m tes	3.6		99	8.06	4.83	4	07	359	74	9		

samples. Arterial blood was obtained by puncture of the left ventricle or one of the femoral arteries and venous blood by puncture of the right ventricle. The blood gas determinations were made on the Van Slyke-Neill (1) manometric apparatus. The circulatory minute volume was calculated from the Fick formula

$$\frac{\text{C cm O consumed per minute}}{\text{Amount O taken up in lungs}} = \frac{\text{No. cm of blood flow through the lungs per minute}}{\text{C cm of blood flow through the lungs per minute}}$$

When the effect of more than one type of drug was studied the same animal was used and sufficient time was allowed to elapse for complete recovery from the previous anesthetic.

## RESULTS

The results are divided for convenience into three groups according to the type of anesthetic employed.

*I Ether anesthesia.* Previous experiments upon the effect of ether anesthesia are reported in detail elsewhere. The present studies are of interest mainly in the comparison which they afford with the other two anesthetics.

The experiments with ether anesthesia were performed upon 8 animals, 5 of which were trained and remained quiet during the control studies without a narcotic. The same results were obtained with both the trained dogs and those which were given morphine. The cardiac output increased during the administration of the ether anes-

thetic in each of the 8 experiments; the percentage increase over that during the control period varying from 4 to 44 per cent. The oxygen consumption usually remained about the same, and the utilization of oxygen (arterial oxygen content minus venous oxygen content) decreased in 7 of the 8 experiments. The pulse rate was accelerated in all instances. The blood pressure was determined in 3 experiments. At the beginning of the anesthesia there was a marked rise in blood pressure which rapidly declined but the blood pressure then remained at a slightly higher level than that of the control period. The results of three typical experiments are given in Tables I, II, and III.

*II Chloroform anesthesia.* Fifteen animals were used in this study, 8 of which were trained and did not require a narcotic. It is believed that the degree of anesthesia which was obtained with chloroform was usually not so deep as that with ether. The pulse rate usually increased but not so much as with ether. The oxygen consumption was decreased slightly in most experiments. The utilization of oxygen was increased in all instances except two. Changes in the cardiac output paralleled alterations in the arteriovenous difference rather than changes in oxygen consumption. The decrease in minute cardiac output varied from 4 to 50 per cent, the amount of decline seeming to be directly proportional to the depth of the anesthetic. The average decrease in the cardiac output



TABLE II—THE EFFECT OF ETHYL CHLORIDE ETHER AND CHLOROFORM ANESTHETICS ON THE CARDIAC OUTPUT AND BLOOD PRESSURE

Drug	Weight kg	Pulse per min	Time min	Arterial O <sub>2</sub> %	Venous O <sub>2</sub> %	Arterial CO <sub>2</sub> %	O <sub>2</sub> consumption ml/min	Cardiac output liters/min	Output per kg per min	Output per beat	Mean arterial pressure
1. 6 spm	5	5		6	5.84	5.76	95.4	656	4	3	
2. 6 spm 5m	5			8	7.56		9.5	5.4	4	6	
3. 6 spm		8			7.88	5.5	9.7	7.83	3	7	9
4. 5 d p			5	88	5	5.6	0	5.6	4	3	95
5. 6 d m			9	93	5.6	5.5		6.1	7	7	
6. 5 m m f			8	8.6	5		6	8.89	6	7	
7. 6					5	6.96		6.55	8	6	
8. f f s			5			6	8	5	3	8	95

was 9 per cent. Changes in the oxygen content of the arterial blood were negligible. Arterial anoxemia was not found in any instance. The decrease in the oxygen content of the venous blood was usually quite marked. Chloroform anesthesia was usually associated with a decrease in the carbon dioxide content of both the arterial and venous blood. The mean blood pressure was found to be lower during the anesthetic in each case in which it was determined.

The results of three typical experiments are given in Table I II and III. Figures 1, 2 and 3 contrast graphically the effect of the three anesthetics under consideration.

III *Ethyl chloride anesthesia*. The experiments with ethyl chloride anesthesia were performed on 11 animals, 4 of which did not require a narcotic. It is much more difficult to study the effects of this drug because of the very narrow zone which separates the lethal from the toxic dosage. A great variation in result was obtained depending upon the degree of anesthesia.

The inhalation of ethyl chloride caused only a slight increase in the pulse rate. The

oxygen consumption was usually slightly decreased. Changes in the arteriovenous difference were variable but it was usually slightly increased. Arterial anemia was encountered in two experiments. The average change in cardiac output was -14 per cent but the changes varied from +10 to -64 per cent. The mean blood pressure was elevated during the early part of the anesthesia but then returned to a level slightly below the control line. The average change in blood pressure at the time of the determination of the cardiac output was -5 per cent.

It is seen from these experiments that the effects of ethyl chloride are quite variable. The early stages of anesthesia are thought to be associated with a slight increase in the cardiac output while deeper narcosis causes a marked decrease. The effects on the circulation seem to be intermediate between those of ether and chloroform.

#### DISCUSSION

The factor which may possibly explain the increase in the cardiac output during ether anesthesia have been previously con-

TABLE III—THE EFFECT OF CHLOROFORM ETHER AND ETHYL CHLORIDE ANÆSTHETICS ON THE CARDIAC OUTPUT

Dose	Weight kg	Pulse per min	Temp per cent	Arterial Pressure per cent	Arterial Oxygen per cent	Arterial pH	Arterial CO <sub>2</sub> per cent	Arterial pO <sub>2</sub> per cent	Oxygen Consumption ml/min	Cardiac Output ml/min	Oxygen Consumption ml/min	Oxygen Consumption ml/min
0.6 Co t l t d y n m rph e		85		7.8	8	6	4.9	49.89	45.4	4.4	83	40
0.3 6 s p m t l t d y m rph e	6		6	6.59	33	5	45.49	49.5	5	43.37	3	4
10-3 6 s p m ft hl o- f r m f s m t	6		6	8.24	7.93	43.65	46.8	250	3.45	5		
10-3 6 s p m t l t tudy o m rph	16		6.46	5	4.05	39.9	4.3	4	43.73	6	44	
0-3 6 s p m ft tb f j m tes	6		17.56	3.68	1.83	33	35.6	3.4	50.38	75	3	
0-6 3 p m c t l tudy m rph	5	8	5	6.0	0	6	3.6	46.3	8.6	47	0	59
0-6 4 p m t l t dy m ph	5	8	5	5.06	6	4	47.05	5	67	7	55	
1 0-6 4 s p m ft thyl hl d f s m t	5	5		6.8	6	66	9.4	83	43.98	5	9	
Pr toe l o- 6 c t l t dy w th ut m rph h lthy t e m ples tak ft l f m h d bee lm t ed f sm t l l						6	1.1	1.1	1.1	1.1	1.1	1.1
p m blood m p l k fte th h d bee lm t f f						3	1.1	1.1	1.1	1.1	1.1	1.1
0-5 3 p m d 4 p m t l t d e w th t m rph						45 p m	1.1	1.1	1.1	1.1	1.1	1.1
de e ly æ th ti d t m blood m ples d												

sidered. The present report consists of a series of observations on the cardiac output and blood pressure during ether, chloroform and ethyl chloride anæsthetics. No attempt has been made to determine the manner by which these changes take place. However the findings by other experimenters are of interest in this regard.

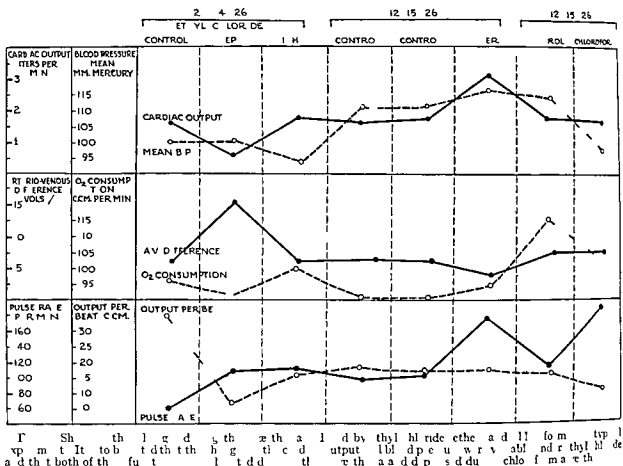
Kodama (9) studied the output of adrenalin by the suprarenals during ether and chloroform anæsthesia. The output was found to be diminished by both of these anæsthetics. Since the cardiac output is affected differently by the two drugs it does not seem likely that the change is instituted by the adrenals.

It is known that anoxæmia may be associated with any of the anæsthetics under discussion. Harrison and Blalock (8) have found that anoxæmia of a severe degree causes an increase in the cardiac output. However the arterial blood was normally saturated with oxygen in practically all of the present experiments and no relationship seemed to exist between the percentage saturation and the cardiac output. Leake and Hertzman (10) state that it is impossible to maintain anæsthesia under nitrous oxide and oxygen with

out some movement. Although the effect of nitrous oxide on the cardiac output of the intact animal cannot be studied satisfactorily by available methods it seems probable that an increase in the output of the heart is associated with it.

Various observers have found that ether and chloroform cause an increase in the hydrogen ion concentration of the blood. Harrison, Wilson and Blalock (7) studied the effects of acidosis and alkalosis on the cardiac output of dogs. Injection of large amounts of acid caused an increase in the cardiac output while the injection of alkali resulted in a decrease in the cardiac output. Previous studies (1) have shown that all of the increase in the cardiac output during ether anæsthesia is not due to the acidosis which is produced. Since the administration of chloroform causes an increase in the hydrogen ion concentration of the blood and a decrease in the cardiac output it seems likely that the change in the output of the heart is not due to alterations in the reaction of the blood.

As regards the effect on the peripheral circulation Cushny (4) states that both ether and chloroform dilate the vessels when they



are perfused through them. Embley (5) in studying the pharmacology of ethyl chloride and chloroform states: "The net result of the action of ethyl chloride upon the vascular system therefore is dilatation but the degree of paralysis is strikingly less than that produced by chloroform even when the latter is present in less than one tenth the quantity in the air inspired." Kanson, Winkle and Laubion (10) injected ether into the iliac artery and noted first a vasoconstriction and later a vasodilatation and swelling of the limb. If the effect on the peripheral circulation of each of these anesthetics is a vasodilatation it indicates that other factors are primarily responsible for the varied alterations in the cardiac output which they cause.

The different effects of these anesthetics on the heart itself are thought to be of more importance. This view is somewhat in contrast to some of the opinions which have been expressed. Cushny (4) states: "The frog's heart

under chloroform or ether beats more slowly and more weakly and at the same time undergoes a certain amount of dilatation all owing to the paralyzing effects of these drugs on the cardiac muscle." Cattell (3) stated that a depression of the heart and a decrease in its output were initiated at the very beginning of ether anesthesia. However, Gwathmey (6) states: "Ether becomes a cardiac depressant only in the later stages of anesthesia or when a toxic amount is employed." Embley (9) states: "The effect of ethyl chloride on the heart muscle as is the case with chloroform and in contrast with that of ether is paralytic but the quantity of ethyl chloride vapor in the air required is 19 times as great as that of chloroform to produce comparable results." He attributed the sudden fall in blood pressure during ethyl chloride anesthesia to vaso-inhibition of the heart while the later decline was thought to be due primarily to cardiac paralysis which was later accentuated by

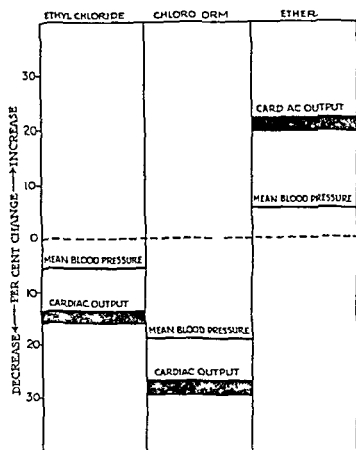


FIG. 1. This figure represents graphically the percentage change in all experiments in the cardiac output and blood pressure. The striking difference in the effect of ether and chloroform is not worthy.

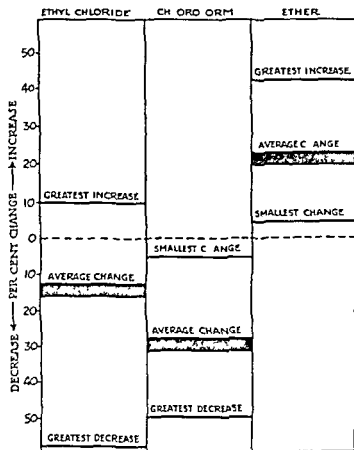


FIG. 3. It is to be noted in the present experiments that ether and chloroform caused an increase in the cardiac output in varying degrees, that chloroform caused a decrease and that the effect of ethyl chloride is variable.

vagus inhibition. These latter observations together with the present report suggest that the factor of primary importance in regulating the cardiac output during the inhalation of these three anesthetics is the action on the heart itself.

It is rather striking (Fig. 1) that the directional changes in the blood pressure during the various anesthetics are the same as those in the cardiac output but to a lesser degree. This fact emphasizes the stability of the blood pressure and suggests that the changes in blood pressure are secondary to alterations in the cardiac output.

It is impossible to state at the present time what effect these anesthetics have on the minute output of the heart of man. However, practically all drugs have similar actions on man and dog. Furthermore, the arteriovenous difference of blood from the femoral artery and vein has been determined in 4 patients before and during the administration of ether

anesthetic. The utilization of oxygen was decreased in each of these instances indicating a more rapid circulatory rate.

The findings with ethyl chloride are in support of the prevailing clinical impression that the margin of safety is small with this drug and that it is not suitable for long continued anesthesia. Since ether and chloroform anesthetics cause opposite directional changes in the cardiac output and blood pressure it seems from the viewpoint of their action on the circulatory system that these two drugs should not be used interchangeably.

Our present knowledge of the advantages and disadvantages of the anesthetics in patients with heart disease is far from being complete. It is believed that the work here reported is a contribution toward the solution of this problem but a final evaluation of the anesthetics which are employed in patients with cardiac disease cannot be made until more knowledge is available concerning the

pathological physiology of the circulation particularly the minute output of the heart in circulatory disorders

## SUMMARY

The cardiac output and the blood pressure of the dog have been studied during the administration of ether chloroform and ethyl chloride anesthetics. Some of these experiments were performed on trained animals while in others the animals were narcotized with morphine. The results were the same whether or not morphine was used.

The more significant findings are as follows:

1. Ether anesthesia caused an increase in the cardiac output in every instance. The mean blood pressure was slightly elevated during the anesthetic.

Chloroform anesthesia was associated with a definite decrease in the cardiac output and blood pressure in every experiment.

3. The changes during ethyl chloride anesthesia were more variable but usually consisted of a slight decrease in the cardiac output and blood pressure. Its effect was thought to be intermediate between that of ether and chloroform.

The possible means by which these changes are instituted are discussed.

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## EMPYEMA IN CHILDREN

## A PRELIMINARY REPORT

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It has for many years been recognized that empyema in adults and empyema in children are in many ways dissimilar and as such present diverse problems to the surgeon and the physician. It is strange however that in the light of this knowledge many results of new and varied treatments have been reported without regard to the age of the patients involved. In some instances when a report on a series of children's cases has been made, no note is made of the definite age of the children involved. That this information is of the greatest importance is evidenced by the fact that the mortality from empyema is about four times greater during the first year than during the fourth.

It is the purpose of this paper to review a series of 371 cases of empyema in children and to study them with regard to age, year of incidence and organism involved.

Of this group 67 were treated in St. Mary's Free Hospital for Children during the years 1909-1917 and 104 were treated in the Children's Section of New York Hospital (First Surgical Division) during the years 1913-1917.

All cases recorded in this series were definitely diagnosed as empyema by aspiration and the roentgen ray and all received surgical treatment. We have not included in this series a number of cases in which no surgical treatment was given due to the condition of the patients or cases which were found by autopsy to be empyematous after death caused by pneumonia.

The children treated at St. Mary's Hospital are for the most part from the poorer homes of New York City, the majority being of Italian parentage.

## ETIOLOGY

Empyema in children is as far as we can judge always a secondary process usually arising from a previous attack of pneumonia.

In our own series fully 9 per cent of all cases were either complications of or sequelae to an attack of pneumonia.

Pneumonia	236
Chronic sinus	11
Bronchitis	8
Access of lung	1
Foreign body	2
Tentinitis	1
Tuberculo	1
Undetermined	10

Apparently general hygiene and social status seem to have some bearing on the incidence of empyema in children. This is based not only on personal observation but on personal communications with a number of pediatricians.

The condition is not so commonly seen during the first year of life as during the 6 years that follow, probably because of the high mortality from pneumonia found in infants under the age of 1 year. During the season of 1915-1916 there was only a single child under the age of 1 year treated for empyema at the hospital. This child was infected with a non-hemolytic streptococcus and recovered fully. During the same period of time there were 41 infants under 1 year treated for pneumonia. Of these 17 died a mortality of 41.5 per cent.

Our figures are in agreement with those of Holt, who found the highest incidence from the condition during the second year.<sup>1</sup> From then on it gradually declines until the ninth year.

The mortality however was much higher during the first year of life than during any of the succeeding years. As is shown in Table I the mortality during the first year was 66 per cent whereas during the second year it dropped to 35 per cent. Holt in his series of 204 cases at the Babies Hospital, New York City, found a mortality of 71 per cent in children under 1 year and 59 per cent in those

TABLE I—AGE INCIDENCE AND MORTALITY

Age	Cases	Mortality
0—	69	33
1	63	7
2	5	4
3	39	8
4	43	5
5		9
6	4	4
7		0
8	3	
9	3	
10	4	

T t l 3 0  
 P l m l l d t wh  
 f p h m l l g b s f h t p m p l d h h  
 d f p l i l i l m p d d p e b f c d t t p p t r h  
 d l i d j d l m p d i d f d i f l f p p t r h

afflicted in the second year<sup>1</sup> Wilensky of Mount Sinai Hospital New York City in a study of 200 cases found a mortality of only 48 per cent during the first year and 51 per cent during the second year.

After the second year the mortality rate steadily declines until about the age of 6 years. After that the deaths are seldom and usually result from some severe complication. The total mortality for our series of 21 cases was 10 per cent, there being 72 deaths. From the first and including the sixth year there was a mortality of 10 per cent. From the sixth to the fourteenth year the mortality was only 10 per cent.

It is of importance, however, to note that there is a wide variation in the mortality rate dependent upon the year during which the case occurred. The percentage mortality varied from 0 per cent in the year 192-193 to 40 per cent in the season of 195-196 (Chart 3).

This marked variation is probably primarily dependent upon the virulence of the infecting organism although there are other secondary factors such as the age of the patient and the specific infecting organisms. One might expect since empyema most often follows pneumonia that the mortality rates of the two conditions would show some rela-

TABLE II—NUMBER OF CASES AND PER CENT OF MORTALITY FOR VARIOUS YEARS SEASONS FROM JULY TO JULY

Season	Cases	Deaths	Mortality %
1905-1906	2	1	50
1906-1907	16	3	18
1907-1908	0	3	0
1908-1909	25	3	12
1909-1910	20	6	30
1910-1911	15	3	20
1911-1912	13		15
1912-1913	0		0
1913-1914	8		
1914-1915	4	4	100
1915-1916	3	5	167

tionship because both conditions are usually caused by the same organism. The exact relationship between the two will be brought out in an article to follow on "The Cause of Death in Empyema in Children and Adults: A Comparative Study."

The condition is most prevalent between the months of November and June as shown in Chart 4. For this reason we have arranged our years from June to June rather than from January to January since the latter obviously splits an individual epidemic into two parts. An individual epidemic probably starts in October and continues to the June of the following year.

#### ORGANISM

The pneumococcus is the most common organism of etiological value found in empyema and carries with it a mortality of about 5 per cent. Table III gives the determinations made in a series of 134 cases.

TABLE III—ORGANISM DETERMINATIONS IN ONE HUNDRED THIRTY FOUR CASES

Organism	Cases	Deaths	Mortality %
Pneumococcus	3	8	6
Streptococcus	3	6	6
Staphylococcus	6	4	66
Mould			4
Streptococcus		6	3

These have been classified according to the age of the patient in Chart 5. Although the number of cases so tabulated is to our mind insufficient nevertheless several facts seem to be borne out. In the first place there is a marked difference between the pneumococcus cases during the first year and during the

If l Loc p s s  
 W l k y Emp m f h ax S g G3 cc & Ob t 9 s ex

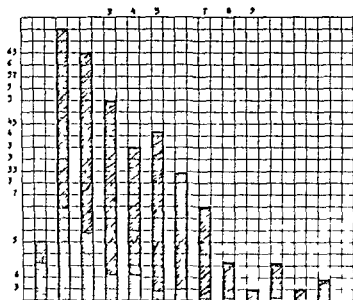


Chart 1 Age incidence of empyema in 31 children's cases. Stippled area indicates deaths.

years that follow. In the first year we find the pneumococcus responsible for only 1 per cent of the cases, whereas in the years that follow the number of pneumococcus cases averages around 60 per cent. This fact gains further weight when it is noted that the cases of pneumococcus empyema in children under the age of 1 year occurred during the same season (1919-1920).

On the other hand, during the first year there is a much higher percentage in cases due to the streptococcus and to mixed infections. The latter is probably due to the fact that almost all pneumonias in children under 1 year are bronchopneumonias in type.

#### SEX INCIDENCE

In the 67 cases at St. Mary's there was a predominance of males over females. The mortality rate in males is also somewhat higher, as shown in the following:

	N of C	N of Deaths	Mortality %
Male	146	33	23
Female	11	1	1

The slight difference between the number of male and female cases in children bears a marked contrast to the condition as found in adults. In a series of 105 adult cases from the First Surgical Division, New York Hospital, we found more than two thirds of the cases

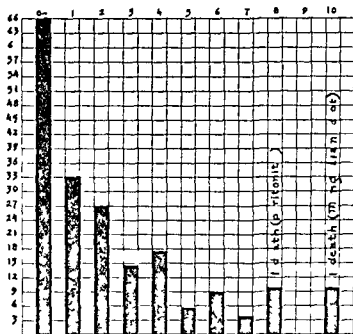


Chart 2 Mortality rates in 371 children's cases.

in men. A comparative study of these cases and our children's series will be included in a future article.

#### LOCATION

Of the 67 cases from the records of St. Mary's Hospital, 135 were on the left side, 105 were on the right side, and 7 were bilateral. Of 161 cases during the last 10 years the following figures were obtained:

	N of C	N of Deaths	Mortality %
Left	91	5	4
Right	63	10	16
Bilateral			100

#### COURSE OF DISEASE

The most common symptoms found are the continued fever after the previous illness, the dyspnea, cough, and the condition of anorexia and general malaise. In some cases pain on respiration is found over the affected side.

Empyema can be easily diagnosed by a combination of physical signs, aspiration, and the roentgen ray. In several cases there was difficulty in diagnosis until roentgenograms were made as the empyematous cavity was situated between two lobes of the lung at some distance from the chest wall. The average temperature during the acute process ranges from 101 to 104 degrees F. In some cases it ran above these figures and in some below.



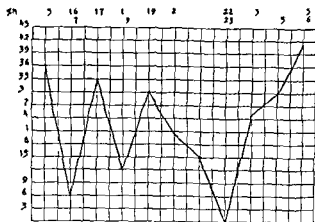


Chart 5. Report of percentage of pus in children 34 cases of pyemia

A study of the leucocyte and differential count presents the most bizarre figures. One hundred and four cases give total counts ranging from 6,000 to 85,000 with an average of 24,000. The one patient with a count of 6,000 and the two patients with counts of 11,000 died. One of those with a count of 11,000 had primary tuberculosis. The average count for fatal cases was 35,000 practically the same as the general average. Sixteen counts of 50,000 or over are recorded. 7 of them in fatal cases.

Of the differential counts the lowest was 34 per cent the highest 98 per cent. The average was 74 per cent. The average count in the fatal cases was 78 per cent. The highest count in a fatal case was 98 per cent the lowest 55 per cent. It will be seen that no prognostic deductions can be made from the total leucocyte or differential counts. All the figures point to a great intensity of infection.

The hospital stay ranged from 1 to 153 days with an average of 6 days after rib resection and 51 days after intercostal incision.

#### TREATMENT

In all cases the first measure taken was aspiration. This was done not only to drain the pus but also in order to determine the nature of the fluid. In the very early cases with thin fluid aspiration was continued until conditions favored open drainage. In only 3 cases was aspiration the only treatment all of the patients dying. They were very ill and operation would probably only have hastened the end.

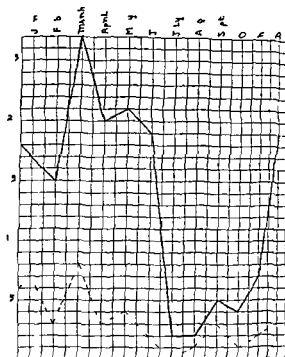


Chart 6. Percentage of pus in children 34 cases of pyemia

In all other cases open drainage was used. Of 226 cases in which operation was performed resection of ribs was resorted to 168 times with 30 deaths 18 per cent. Intercostal incision with open tube was used 58 times with 19 deaths 33 per cent. The high mortality found with the intercostal incision is due to the fact that it was frequently used when the patient was too ill to undergo general anesthesia and the shock of a rib resection. That it is not so severe as the figure might indicate is shown by the fact that the mortality rate of the cases in which operation took place at the hands of one of the surgeons who use only intercostal incisions is comparatively low when compared with that of the other operators who rely chiefly on rib resection.

No case was treated by trocar tube nor by aspiration followed by antiseptic injections. Dakin's solution has been used without especially brilliant results simply to cleanse the open cavity. With rare exception the benefit caused in children has seemed to outweigh the advantages. It is a debatable question also whether digestion of the pleural surface is a wise measure in acute cases.

Binney in 1914 reported a series of 100 cases treated with closed drainage of which 35 were in children from 1 to 10 years old. Of these there were 5 deaths or a mortality of 14 per cent.<sup>1</sup>

In our series there were 550 patients under the age of 10 of whom 7 died a mortality of 0 per cent.

In spite of the scarcity of cases presented by Binney his results are to say the least of great interest. It is of importance however to know the ages of the patients so treated the mortality for the various age groups and the year or years in which the cases occurred.

Ladd and Cutler report a series of 4 cases in which there were 1 death a mortality of 8 per cent. Although they do not give the age groups they state that the majority of the deaths occurred in infants in whom the mortality would have been high anyway. The figures in Table IV may be of interest concerning the relative merits of the open and closed method.

TABLE IV—RELATIVE MERITS OF OPEN AND CLOSED METHODS

	Cases	Deaths	Mortality	Open	Closed
St. Mary's Hospital and					
New York Hospital (open)	371	2	19	1	3
Binney (closed)	35	5	14	1	
Ladd and Cutler (open)	26	36	19	0	4
Ladd and Cutler (closed)	42	1	5		50
Of all					

#### ANESTHESIA

Of 150 cases operated on between 1916 and 1917 ether was used 138 times with a mortality of 16 per cent. Novocain was used 10 times with a 60 per cent mortality. The figures are as follows:

TABLE V—ANESTHESIA

	Cases	Deaths	Mortality
Ether	138	22	16
Novocain	10	6	60
Ethyl chloride	1	0	
Chloroform	1	0	
By anesthesiologist			
Dr. B. S. J.	94	6	4
Dr. C. J. D.	9	546	

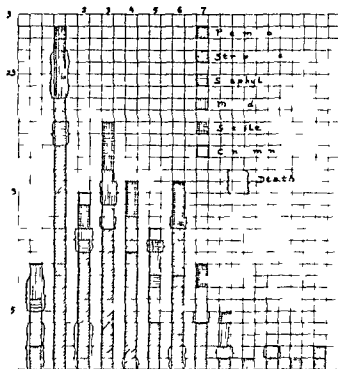


Chart 5. Percentage of mortality from empyema in children during the years 1915-1917.

The above statistics are of little value inasmuch as the cases in which novocain was used were often of such a serious nature that general anesthesia could not be used.

A study was also made of the mortality by operators during the years from 1916 to 1927. In this series are included only operators with 10 or more cases (Table VI).

TABLE VI—MORTALITY BY OPERATORS

Operator	Cases	Deaths	Mortality
Dr. U.	0	5	0
Dr. V.	16	5	31
Dr. W.	3	1	33
Dr. X.	7	3	43
Dr. Y.	6	4	67
Dr. Z.	22	1	5

These figures are of little significance unless the following points are taken into consideration:

1. The tendency for certain operators to do only the more severe cases and let the internes do the others.

The seasons during which the operators were on service. (It is of interest to note in this connection that all the cases in which Dr. V. operated occurred during 6 months of a year when the mortality rate was high.)

SEASON	0	1	2	3	4	5	6	7	8	9	10	11	12	13	TOTAL
15-16		OP 2/11	2/11	P 2/11	O 1/1	O, P, S 2/11	OO 1/1								22
16-17		SP 2/11		P 2/11	P 1/1	1/1	1/1	1/1	1/1		S 2/11				15
17-18	S 2/11	P 2/11		PO 1/1	O P 1/1	O P 1/1	P 1/1								13
18-19		OPP 2/11	P P 2/11	PPP 1/1	PPOM 1/1	P S 1/1		P 1/1					1/1	1/1	23
19-20	P P 2/11	POPP 2/11	PO 2/11		S S 1/1		OPP 2/11	O P 1/1		M 1/1			S 1/1		20
20-21	M M 2/11	P S 1/1	P 1/1	M P P O 2/11	P 1/1		P 2/11	P 1/1	M P 1/1					P 1/1	15
21-22		P 1/1	O 1/1	S P O 2/11	S 1/1	S 1/1		S 1/1			P 1/1				9
22-23			P 1/1	O 1/1		P S 1/1	S P P P 1/1								8
23-24		P P 2/11	P 1/1		P 1/1	P 1/1	S 1/1								7
24-25	S 2/11	P 1/1	M P 2/11	P P 1/1	P P 2/11	S 2/11	S P 1/1	P 1/1	S 2/11				P 1/1		14
25-26	S 2/11	POPS 2/11	P P 2/11	P 1/1		P 1/1		S 2/11	S 2/11						12
TOTAL	10	31	18	26	16	15	17	12	4	1	3	1	3	1	158

## PERITONITIS

Ch t e Ag r n m l m t l t l v of s t c l p m c S t p t c c s staph lo  
c o t l l m d M l a l y

3 The year during which the operations were performed

4 The age of the patients

Dr Y used only the intercostal incision

## COMPLICATIONS

Complications are frequent in empyema. Blocking of the exit really an incident rather than a complication, but it occurs very commonly and must be kept in mind when any untoward symptom develops. Pocketing is also fairly common but in children is usually simple easily detected and is easily remedied. Aspiration of the tube is occasionally seen. A rare accident is the unrecognized loss of part of the tube within the chest cavity. A roentgen ray or fluoroscopic examination should be made at not too long intervals. The opposite chest can thus be kept under observation. Osteomyelitis of the rib occurs in a small proportion of the cases rather less in the intercostal type. Again the roentgen

ray is of the greatest assistance in detecting the presence and extent of the trouble. Necrosis of the rib is a fairly common cause for persistent sinuses and local pocketing. It rarely produces a late recurrence.

Acute anemia of varying degree is a constant complication of empyema. Repeated red cell counts and hemoglobin estimation should be made. The judicious use of blood transfusions is to be commended.

It may also be remembered in this connection that in drainage of the cavity the child is losing a great deal of body fluid as well as body proteins. It is therefore necessary to force fluid and to give plenty of nourishment. Bell has figured that adults lose as much as 1 gram of nitrogen per day.

The complications which occurred in 168 cases at St. Mary's Hospital during the year (1916 to 1927) are as follows:

E A C h m n d R D B l S m P I I ed  
m t m p m s g c c c O b g x m b o

Otitis media	C	12	Fry apelas	C	5
Neumonia of same side		11	Peritonitis		2
Neumonia of opposite side		8	Nephritis		
Bronchopneumonia		9	Pericarditis		
Lung abscess		7	Scarlet fever		
Pneumothorax		4	Gangrene of lung		1
Tonsillitis		3	Osteomyelitis of rib		1
Furunculo is			Banti's disease		1
Tuberculo is			Chicken pox		1
			Measles		1
			Castro enteritis		1

## HISTORICAL

The prognosis seems to be dependent upon a number of factors. The most important of these are age, complications, virulence of organism, condition of patient, and treatment.

We have already shown the relation of age and virulence of the organism to the mortality, and have pointed out the complications that occurred. It is of interest to note how ever that of 33 deaths occurring at St. Mary's between the years 1916-19, 19 were complicated by serious conditions. Nineteen of these were sympleuronic, 3 were complicated by lung abscesses, 3 by peritonitis, and the remainder by such conditions as pericarditis, gangrene of the lung, furunculosis, and acute nephritis.

It would appear that the cases having resistance sufficient to outlast the first onslaught of infection and to localize it become surgical possibilities. Our mortality seems to be a measure of the intensity of the infection and the onset of severe complications. This is suggested by the postoperative day of death.

The average period of life in fatal cases was 15 days after operation. In the cases in which death occurred during the first 3 days in almost every instance the condition of the patient had been very poor at the time of operation. Deaths at a later period than this were usually due to severe complications.

In our series of cases there seemed to be little relationship between the time from the previous illness to the diagnosis of empyema and the mortality. It is probable that the thickened pleura which was found in a number of the fatal cases has some bearing on the final prognosis but in all cases it seemed to be of only secondary importance.

So far as the surgical treatment is concerned the most important factor is the

knowledge of when to operate. Operation before the pus is thick and the cavity well walled off increases the gravity of the prognosis to a marked degree.

## CONCLUSIONS

1. Empyema is a complication in nearly all cases of a persisting and serious disease.

The incidence of empyema varies as regards age, year, season, and organism. It probably bears a relationship to the prevalence of pneumonia and to the virulence of the affecting organism.

3. The mortality in infancy is very high. From then on it drops rapidly until the age of 7 and remains extremely low in adolescence and early adult life. Age seems to be the most important factor but the type of infection, the year, and the virulence of the organism also have a great bearing on the prognosis.

4. It appears from the figures obtained that the time between the preceding illness and the diagnosis of empyema is only of secondary importance as regards prognosis, the main factors being the virulence of the organism and the general condition and resistance of the child.

5. Death from empyema in children is in almost all instances due to a general condition of debility brought on by the previous illness or due to existing complications and not to the empyema itself.

6. The various methods of treatment now in use—the use of the intercostal incision or rib resection, open drainage or closed drainage, Dakin's solution or simple drainage—seem to have little influence upon the prognosis.

7. The time of operation following the diagnosis of empyema depends entirely upon the individual case and the surgeon should be guided by the nature of the pus and the general condition of the patient.

8. Recurrences seldom result if free drainage has been obtained and maintained until the closure of the wound.

## DISCUSSION

DR. HOWARD LILIENTHAL: Attention should be called to the importance of a proper estimate of the gross pathology in cases of empyema. It is not

scientific to consider a case of suppurative pleurisy as represented by a single cavity. The cause of empyema is usually infection from the surface of the lung and this may start from more than one focus. Indeed I have operated in many cases in which by free intercostal incision with ocular examination it was possible to identify several in one case as many as 5 different pockets each having apparently risen from a separate focus and no two alike as to the character of the exudate varying from seropus to thick pus. Indeed multiple empyema cavities were fairly common and frequently the different sacs contained different organisms. However I have found that as a practical method the primary treatment by trocar and cannula with the insertion through the cannula of a small multifenestrated rubber catheter about 14 F. with a very soft finger cot valve attached would in about one third of the cases re-

sult in a complete recovery without injection or lavage of the thoracic cavity. The cannula is removed leaving the catheter in place. The soft finger cot is then tied firmly to the end of the catheter outside the chest and finally a generous slit is made in the end of the finger cot. With every expiratory effort fluid with or without air is forced out while on inspiration the sides of the finger cot are sucked together preventing air or fluid from entering the chest.

If the course of the convalescence is untroubled the exudate gradually becomes serous and when X ray examination demonstrates full expansion of the lung then the tube can be withdrawn. If however there is continued fever or other signs of sepsis an X ray examination should be made after 5 or 6 days and other loculi of pus if discovered should be treated by more radical surgery.

OBSERVATIONS ON THE INTRAMURAL AND ISTHMIC PORTION  
OF THE FALLOPIAN TUBES WITH SPECIAL REFERENCE  
TO SO-CALLED ISTHMOSPASM\*BASED ON CLINICAL X-RAY LIPIODOL STUDY AND UTEROTUBAL INSUFFLATION IN 50 CASES  
OF TUBAL OCCLUSION

IRVING RUBIN, M.D., F.A.C.S., NEW YORK

SINCE a method of localizing tubal obstruction has been found increasing attention has been given to the narrowest portion of the fallopian tubes which traverses the uterine musculature at either cornu. It is but natural to assume that this portion of the oviduct measuring as it does from 0.5 to 1 or at the most 1.5 millimeter in diameter might be occluded readily by inflammation and intra-uterine tumor or temporarily obliterated by uterotubal spasm. As its function is to offer passage to the young impregnated ovum the presence or absence of anatomical anomalies and inflammation of some importance in a consideration of the etiology of sterility. Certainly from a theoretical point of view spasm of the tubes particularly if its incidence can be proved to be as high as has been claimed must also be a causative factor.

Several publications have appeared recently dealing with the anatomical and pathological study of the intramural portion of the tube notably those of Hermstein and Neustadt (3) and of Geist and Goldberger (4). The conclusions of both papers are based upon skiagraphs made of injected extirpated specimens of uterus and tube. The specimens were removed because of fibromyomata alone or bilateral disease of the adnexa or a combination of the two. Emphasis was laid upon the *tortuosity*, angulations and convolutions of the intramural portion in these cases—a condition which occurred according to Hermstein's and Neustadt's report in 34 per cent out of 15 specimens examined. Geist and Goldberger in confirming these findings in the anatomical material go farther in their conclusions as applicable to problems in sterility. They claim that in an appreciable number of cases of sterility the tortuosity of the tubes at their

exit from the uterine cavity as found in the extirpated specimen is responsible for the high pressure reached during clinical utero-tubal insufflation. They maintain this to be a cause of obstruction to spermatozoa and leave the impression that this condition is a factor in sterility more commonly than has hitherto been recognized. Other clinical deductions made by them are based upon their anatomical study.

Of the specimens studied by Hermstein and Neustadt 9 were resurrected from among specimens which had been immersed in formalin solution for some time and the remaining 6 were removed from the fresh cadaver. Mercury was used by them in the injections. The specimens studied by Geist and Goldberger were removed by operation, injected with 20 per cent sodium iodide solution and skia-graphed before being immersed into formalin. The latter authors believed that they were dealing with living organs because of their irreversibility.

There can be no question as to the importance of these anatomical studies as such or of the careful and painstaking work reported by these authors. But the interpretation of their findings and conclusions because of their clinical implication may be subjected to further scrutiny.

Neither the formalinized specimen nor the so-called fresh specimen maintains the functional conditions found in the living intact organ or in the *surviving* extirpated organ. The uterus and tubes removed at the operation unless properly preserved in suitable oxygenated solutions die rapidly and undergo the changes of rigor mortis. It is a common observation that tubes become markedly contracted and thicker as soon as they are removed from the body. The tube lumen can thus become more sinuous especially at the intersti-

tial portion where the powerful muscle is in contraction. *The pictures of the intramural portion of the fallopian tubes obtained in the living are entirely different from those shown in the dead state.* Comparison with the shadowgraphs of uterus and tubes made by early personal clinical studies with collargol thorium and sodium bromide (13) brought out the difference in a striking way. Shadowgraphs of the myomatous uterus and tubes when removed from the body however presented a tortuous appearance of the intramural portion (14).

The tortuosity in the injected specimen as L. Dickinson (15) has pointed out may be due to artificial conditions such as pressure upon the specimen exerted during the injection. Dickinson expresses the opinion that the tortuosity might not have been found if the specimen were immersed upside down in water and the uterine cavity injected while an even water pressure surrounded the uterus. It will be recalled that in the living the uterus is suspended by its ligaments and during injection the intra-abdominal pressure is equally distributed over its surface and uniformly maintained so that there can be no eccentric pressure in any one portion. In myomatous uterus moreover the distortion may be due to the encroachment of the tumors upon the uterine cavity particularly when they are situated near the horn.

3. Experiments upon the surviving uterus and tubes of the pig (16) and also upon the organs in the human subject (17) have shown that under untoward conditions muscular contractions can be conceived for from 1 to 3 hours and their behavior is quite analogous to that of the living intact organ. It has seemed therefore as if a truer picture of the intramural portion of the tubes would be presented by injecting the uterus clinically. As fibroid and gross pathological disease of the tubes such as bilateral pyosalpinx are too plainly involved in the etiology of female sterility and as the second of these two conditions contraindicate the use of carbon dioxide insufflation or even lipiodol they were excluded from the present study.

In this study only those cases of sterility were selected in which the tubes had been

previously demonstrated by repeated test with peruterine insufflation to be totally occluded or markedly stenosed. It was felt that in this class of cases the possibly deleterious effect from lipiodol injections would either be avoided or if present would at least be minimized. Although more complete physiological data could be obtained in the study of normally patent tubes it appears better for the present and until a perfect contrast medium is available to restrict our study to more or less occluded tubes. Lipiodol was selected as the contrast medium because it has so far proved to be the most satisfactory of all the radio-opaque substances employed. It should be borne in mind however that the injection of lipiodol may be followed by untoward sequelae. In the present series for example the latter were encountered 4 times out of the 50 cases examined.

When the tubes are occluded at the fimbriae the appearance of the intramural portion can be studied in the living exactly as in the extirpated specimen because in this instance instead of a ligature being tied about their abdominal end, nature has sealed them by adhesions of internal occlusion.

In the 50 cases examined by means of lipiodol injections and the X-ray the tube has been found to emerge from the uterine cavity in a straight course in almost every case in which the tube shadow appeared on the film (Fig. 1). An L-shaped course so common apparently in anatomical specimens was observed but once and that in an elderly nullipara on the side showing a hydrosalpinx (Fig. 2). Obviously this abnormality cannot be held responsible for the obstruction in this case. The intramural portion was naturally absent in those cases in which the entire tubes had been removed at the laparotomy. Of the 50 cases the interstitial portion was seen 5 times or both tubes being present. In 16 cases they were absent because of previous surgical removal of both tubes.

1. j t l t h l p l l  
Sh w g l t h t b  
Sh t t l nly  
Sh h t l t l  
Sh w t l t l h t t b t m p  
Sh g d t l h t t b t u p  
T t l m b f es









FIG. 3. Fluorogram showing isthmus portion of right tube completely filled. Left isthmus markedly narrowed therefore not appearing on the film.

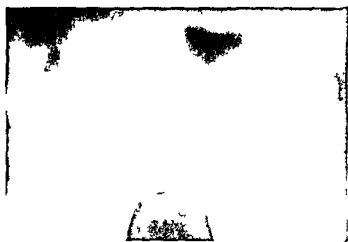


FIG. 4. Fluorogram showing absence of isthmus shadow on left side. Same contrast medium as illustrated in Figure 3 in which the entire isthmus is beautifully shown (contrast fluorogram).

narrower as it passes through the uterine wall where its mucous membrane is thrown into primitive folds which have a trifol or clover leaf shape to a star or H shape on cross section. This portion outside of the uterine wall is palpable as a whip cord between the fingers, the sensation imparted being due to the presence of reinforced circular muscle. Unfamiliarity with this anatomical fact has led to misinterpretations and to useless operations. Kennedy (6) believed he was dealing with closed tubes in one case because the isthmus felt as though it contained a fibrous core on both sides. It was decided that they were the seat of obstruction. They were excised and a hysteroligingo anastomosis was done which rendered the tubes patent and relieved the dysmenorrhœa but not the sterility. Carbon dioxide insufflation by Aldridge had previously shown these tubes to be normally patent. Serial section of the excised isthmus showed them to be normal.

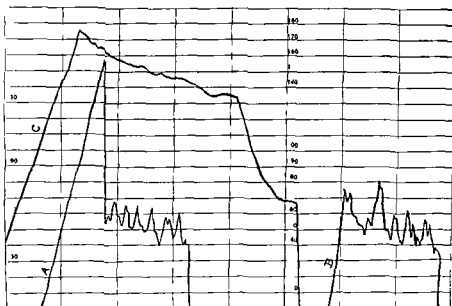
The wider portion or receptaculum ovuli feels much softer between the fingers and begins about 1/2 or near the middle of the tube. It is provided with numerous mucus folds which lie almost contiguous and present on cross section a labyrinthine appearance. The abdominal end opens up in a somewhat constricted lumen from which radiate the fimbria. This however will for example permit the passage of a uterine cannula in contrast to a fine filiform bougie which can scarcely be introduced into the intramural portion. In the

lower animals as the pig the fimbria ovarica is thinned out and broadened into an enveloping membrane which covers the ovary almost completely thus securing a more successful reception of the ovum as it is cast off and by peristalsis pushed well on through the ampullary portion. The outer end of the tube has been termed the pars fimbriata and the uterine end the pars uterina.

#### THE QUESTION OF ISTHMOUSASM

The difference in anatomical structure between these portions is parallel with their physiological difference. If the tubes of the pig are observed in peristalsis it will be noted that the narrow portion which is nearer the uterus undergoes more pronounced contractions than the outer end.

In the presence of a foreign body such as lipiodol the human fallopian tubes may be seen to undergo peristalsis beginning at the ampullary portion and traveling toward the uterus. Reversed peristalsis is not uncommon. The contractions appear to be more powerful at the isthmus portion. The narrow portion is not so easily visible under the fluoroscope as it has the width approximately of a coarse hair. That accounts for its apparent absence in some cases. Kennedy (7) found this absence of isthmus shadows in 38.3 per cent of the tubes he examined with sodium bromide solution and the X rays. He therefore concluded. Inasmuch as the ampulla of the tube ren-



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found that the isthmus was demonstrated in every instance in which the tube had not been previously removed by operation or was not obliterated by disease. In one instance the isthmus was seen by the fluoroscope but not on the X-ray film. This meant that the lipiodol had been discharged simply into the abdominal end of the tube or back into the uterus and out. The fluid is not only rapidly emptied from the isthmus, but as its lumen is very narrow at best, too little is left to render a contrast shadow. If serial roentgenograms are made it will be found that the isthmus will appear on the X-ray plate at one moment and not at another. This does not, however, indicate isthmospasm in the sense that pyloric spasm, for example, is generally understood. It is simply the contraction phase of normal peristalsis (Fig. 4).

Arnstam and Reinberg brought this out (11) in a recent serial roentgenological study of the uterus and tubes with the aid of lipiodol (metrosalpingography). If intra-uterine pressure with the fluid is maintained, the isthmus will be seen each time, because peristalsis is paralyzed by the distending fluid. When the pressure is slight or even moderate, peristalsis returns and the isthmus as well as the ampulla exhibit contractions. Because of its narrow lumen, the isthmus will not cast a shadow on the film unless a very densely opaque substance is used and the exposure is taken in the dilating phase. Its lumen on the other hand is wider at times than at others, showing that it is capable of dilatation. If the patient is examined with the fluoroscope a few hours after the initial lipiodol injection, it will be seen that the closed ampulla is filled while the isthmus is empty. The ampulla remains filled with lipiodol for weeks and months, the fluid accommodating itself to the more dilated portion of the tube where it rests because of weak or totally absent peristalsis.

That there may be an augmented tonicity of the isthmus tube as well as of the whole tube may be readily granted. In studying tubal patency by means of peruterine insufflation and the kymograph it has been seen that sometimes the initial pressure required to overcome the resistance at the uterotubal junction and the isthmus resistance may be as high as



FIG. 4. Entire kymogram showing gap in tube at uterine junction on the right (11) (junction reaction). Contrast this with appearance of film when the tubo-uterine junction is dilated.

200 millimeters mercury. Once this has been overcome the flow of the gas is freer and there is a steady drop as the undulations appear on the recording drum and in the manometer (Fig. 5 a). This occurs in a small proportion of the cases examined. Contractions of the tube vary in strength between 5 and 30 or 40 millimeters mercury. Exceptionally the manometer fluctuates between 70 and 90 millimeters mercury. Fluctuations are noted on the drum soon after the gas passes the uterotubal junction and are recorded in practically every normal case. The presence of manometric fluctuations distinguishes the normal tube in hypertension from a strictured tube or one which is diseased and bound down by adhesions. In the latter case if the tube is not absolutely occluded the gas may succeed in passing at a high pressure and after a drop find a level at which it continues to flow as long as the gas pressure is maintained. But there will be a complete absence of fluctuations in the manometer and of corresponding undulations on the kymograph (Fig. 5 c).

#### THE FREQUENCY OF INCIDENCE OF TUBAL SPASM AS A CLINICAL ENTITY

Observations of many cases in which the question of tubal patency was determined indicate that the incidence of tubo-uterine spasm is not very frequent. It occurred about

9 times out of 450 cases in which the examination was made with a kymographic attachment. That is the tubes were found to be patent after an initial high pressure (150-190 millimeters mercury) was required to force the gas through them. It has been pointed out elsewhere (15) that in the premenstrual and menstrual stages of the ovulation cycle higher pressures were necessary than in the postmenstrual phase. Ierudin and C. Lee (9 and 10) showed that in some of the laboratory animals it was always easy to inject from tube to uterus where when an injection was made in the reverse direction—from uterus to tube—the injection mass would pass with much greater pressure through the tubouterine junction. But when the animal was found to be near the time of ovulation the injection mass would pass more readily requiring less pressure. The tubouterine junction is apparently guarded by a sphincter apparatus analogous to the pyloric sphincter although as in the latter no definite muscle bundles have so far been demonstrated (Fig. 6). Ierudin's experiments with gas insufflation in the living animal and upon surviving extirpated specimens of intact uterus and tubes point to a definite very small zone corresponding to the intramural portion of the tube which is capable of contracting and dilating like a true sphincter. Peinberg and Arnstam have described it and recently Schmidt and Lisler have independently raised the question as to whether there is a sphincter apparatus at the tubouterine junction (18). The present series of lipiodol studies corroborates their findings. (This will be taken up in the near future.)

#### CONCLUSIONS

The intramural portion of the fallopian tube in the living paruae is straight, contrary to what is found in the anatomic specimens. It is capable like the rest of the tube of contracting and dilating. Total obliteration of its lumen is very infrequent and when present is part of more extensive tubal disease. Isthmopism is an entity has not been definitely demonstrated but tubal contractions can be seen with the aid of intrauterine lipiodol injection and the fluoroscope. The uterotubal junction (intramural portion) appear to be

the site of predilection of spasm or hyperactivity in a relatively small proportion of the cases examined. It was demonstrated by uterotubal insufflation with the aid of the kymograph in 2 per cent of 450 cases of sterility. It can also be demonstrated by fluoroscope and X-ray film aided by lipiodol and manometric control. A sphincteric action at the tubouterine junction has been evidenced in clinical and experimental observations.

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# CLINICAL SURGERY

FROM THE LEISIA INSTITUTE OF HELIOTHERAPY

## HELIO THERAPY IN HIP JOINT TUBERCULOSIS

By A. KOLLER, M.D., LEISIA, SWITZERLAND

D. t. d. f. t. b. sem. t. H. f. t. p. q. d. L. j. La. (t. d. l. A. d. d. M. d. d. P.

THE cures obtainable by heliotherapy are distinguished by three principal characteristics: a splendid general condition, development of the musculature and frequent return of function in diseased joints. This last result is of particular interest in tuberculous hip disease and for this reason we shall devote our main attention to this form.

Believing that in tuberculosis the question of the oil is of capital importance while the bacillus plays a secondary role we have recommended from the beginning of our work general heliotherapy that is to say the methodical insolation of the total surface of the integuments. We have also arrived at this conclusion because we believe that the skin is not only an organ of protection but also a very important organ of defense. It plays a leading role in the general metabolism and is able to subserve its physiological functions only when placed in direct contact with its natural milieu: air and sun.

Proceeding from these principles we have applied since 1903 general heliotherapy to so called surgical tuberculosis and we have sought to build up a real therapeutic system based on a precise posology and associated with a rational orthopedic technique which broke with the traditions hitherto accepted. Heliotherapy of this kind in association with the air bath for which the altitude is particularly suitable stimulates admirably the natural defenses of the organism and brings about its complete reconstitution while at the same time providing the ideal local treatment thanks to the analgesic, resorptive and sclerosing properties of the solar radiations.

The action of the sun is first of all general and manifests itself on all the systems: the skin, the musculature, the blood, the endocrine organs and the skeleton itself.

The skin when placed in contact with the air and sun is toned up and pigmented; it regains its

many physiological functions and becomes once more the real garment provided by nature. Thanks to the fine mesh of capillaries alternately dilating and contracting it forms by this expansion of the vascular system a peripheral heart. Through its multiple nerve endings for touch and pain it also becomes another expansion of the nervous system. The skin is also the vicar of the kidney, secreting as it does more than one liter of sweat per day with sebaceous matter and various toxic substances. It is furthermore the most important source of immune bodies, probably also the most important endocrine organ.

Skin when pigmented and thus physiologically adapted to heat and cold resists the penetration of germs; the cicatrization of wounds is thus favored and such a skin is refractory to many cutaneous affections. The pigment serves not only as a protection against over-irritation by the ultra-violet rays but also as a regulator of the sun's heating power. It probably plays an even more important part: it is supposed that it acts as a kind of accumulator of dynamic forces and our experience tends to confirm this view inasmuch as a patient's resistance is generally proportionate to his pigmentation. It becomes indeed increasingly evident that the skin receives, furnishes and activates the essential elements for the metabolism of hormones and vitamins and it is probable that the majority of the avitaminic conditions are simply due to lack of sun.

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## HELIOGRAPHY IN HIP JOINT TUBERCULOSIS

BY A. KOLLIFER, M.D., LEISIN, SWITZERLAND

Dr. t. d. E. t. b. sem. t. H. l. th. p. q. e. s. d. L. j. La. (t. d. l. A. d. m. d. M. l. f.

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Believing that in tuberculosis the question of the oil is of capital importance while the bacillus plays a secondary role, we have recommended from the beginning of our work general heliotherapy, that is to say, the methodical insolation of the total surface of the integuments. We have also arrived at this conclusion because we believe that the skin is not only an organ of protection but also a very important organ of defense. It plays a leading rôle in the general metabolism and is able to subserve its physiological functions only when placed in direct contact with its natural *milieu*: air and sun.

Proceeding from these principles, we have applied since 1903 general heliotherapy to so-called surgical tuberculosis, and we have sought to build up a real therapeutic system based on a precise posology and associated with a rational orthopedic technique which broke with the traditions hitherto accepted. Heliotherapy of this kind in association with the air bath, for which the altitude is particularly suitable, stimulates admirably the natural defenses of the organism and brings about its complete reconstitution while at the same time providing the ideal local treatment thanks to the analgesic, resorptive and sclerosing properties of the solar radiations.

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By restoring to the muscles and ligaments their natural tone the sun cure re-establishes the normal balance of this lever mechanism and thus by an eminently physiological process brings about the return of articular function.

The sun's action is exercised not only on the muscles but on the bones. We have about 50,000 X-ray plates which prove beyond question that no lesion however deeply situated remains insensible to the solar radiations. The first sign of cure in bony lesions is recalcification but this recalcification of the bony skeleton is not peculiar to tuberculosis it is a commonplace in the treatment of rickets and of other bony dystrophies. We drew attention to this property from the beginning of our work in 1903 and the question has of late years been studied by many authors particularly Hess of New York and his collaborators Passenheimer and Ungern who have demonstrated an increase in the calcium and phosphorus of the blood under the action of light. This remineralization of the organism is contemporaneous with a steady increase in the percentage of hemoglobin and of the number of red blood corpuscles. Further the sun cure especially in mountain air causes an increased respiratory activity which improves the heart action and the general circulation. The metabolism is increased the appetite awakened the digestive functions invigorated and the strength is recovered. Finally heliotherapy has a favorable action on the internal secretions due to the stimulation of the endocrine glands by the solar radiations.

While then general heliotherapy can restore to the body undermined by tuberculosis a normal physiological function and a symmetrical harmony its local action is of equal importance in the treatment of bone tuberculosis and particularly in hip disease. The solar radiations are analgesic pain rapidly diminishes and finally disappears under their influence combined with that of a suitable extension. The resorptive power is shown by the fact that periarthritic oedema and infiltration steadily decrease and finally their cicatricial action is proved by the recalcification of bone evident on the X-ray film. The sun has also a valuable cleaning action on sinuses and by its bactericidal action rapidly heal the most obstinate and chronic wound. It is of fundamental importance to remember that heliotherapy will not give such valuable results if it is used haphazard.

A rigorous dosage and strict technique are primary essentials. We have established certain principles of dosology applicable to all cases which are of such importance that I feel compelled

to state them briefly. Dosage must be so graduated that the reactions produced by the solar radiations in the organism are never of harmful intensity. This requires of the doctor an active control and a strict individualization (careful examination of each case on arrival slow gradual adaptation first to the open air and then to the sun careful study of the general and local reactions which may occur during treatment and which are for the doctor the most valuable indications for the further progression of insolation, etc.).

On arrival a case of hip disease is immediately relieved of his plaster apparatus. After a few days of repose and acclimatization immobilization and extension are begun. In some cases extension must be applied immediately after removal of the plaster to combat pain and tend not to dislocation. The patient remains at first in his room with the windows open where he accustoms himself gradually to the altitude. Then if he shows no general reaction attributable to climatic condition (e.g. rapid pulse subfebrile temperature nervous excitability etc.) his bed is rolled out on the balcony to accustom him to the open air. After a period which depends for its length entirely on the observations of the doctor (general resistance of the patient state of his organs presence or absence of secondary infection with or without elevation of temperature etc.) the sun cure proper can be started.

The reaction of the organism to the sun both local and general varies with each patient and it is essential to regulate the sun bath according to the individual indications. The optimum duration of insolation in each case is easily determined by careful observation. We have nevertheless drawn up a simple schema to serve as a general guide. The main principle is in every case to start with the lower limbs. This is an obviously rational precaution for by exposing first the legs and feet a neutral region which can be insulated with a longer one can measure the degree of the patient's tolerance of the sun and thus acquire at the start valuable indications for the continuation of treatment. This method by causing a flow of blood to the lower limb has a marked decongestive action on the thoracic and abdominal cavities. Our long experience has taught us that by the correct use of heliotherapy as above described even the most advanced cases run the risk of accident.

The first exposure to the sun is therefore very brief. On the first day the feet are exposed 3 times for a period of 5 minutes each with a half hour interval between exposures. On the second day the feet are given 3 periods of 10 minutes each and



Fig. 1 Patient suffering from tuberculous hip disease with sinuses showing apparatus of extension and how the work is practiced with the sun cure

the legs 3 times of 5 minutes up to the knee. The following day 3 times of 15 minutes for the feet 3 times of 10 minutes up to the knee and 3 times of 5 minutes to the hips. On the fourth day the abdomen is exposed to the sun and the fifth day the thorax with a damp cloth protecting the precordial region. The upper regions of the body should be exposed with great prudence. During this time the condition of the patient his temperature pulse and particularly the local reactions are carefully observed and at the least sign of intolerance the periods of insolation are shortened or momentarily suspended. This schema is of course susceptible of variation in accordance with the patient's degree of resistance his sensitiveness or nervous temperament. It is essential to individualize and vary one's methods for each case if good pigmentation is to be obtained in the minimal time without accidents. Insolation of uninfected tuberculous hip joints for instance demands a quite different procedure than do those cases in which infected abscesses (not cold abscesses) and sinuses are present. In the latter type local reactions are common with rise of temperature and abundant suppuration such reactions are often injurious when they are too acute and they must be kept within bounds or in some cases completely avoided. This demands careful individualization guided by an instinct which is only acquired through experience. When

the body starts to pigment insolation of each region may be doubled and the patients exposed to the sun for several hours. Experience has however proved that it is useless and sometimes dangerous to prolong the sun bath immoderately generally speaking 3 hours a day is a reasonable average. During hot weather the sun should be taken in the early morning hours to avoid overheating which both congests and exhausts the organism.

Heliotherapy alone cannot of course bring about the cure of hip disease with correction of orthopedic deformity. Rational orthopedics must be used as an adjunct. The following principles form the basis of our orthopedic practice. In the first place we have broken with the old tradition of which the main dogma was the closed plaster apparatus. From the beginning of our work we considered the wearing of such apparatus to be in contradiction with true physiology and orthopedics. These impermeable shells by depriving the diseased region of air and sun destroy the local resistance at the very place where it is most needed. Their use causes rapid atrophy of the integuments atrophy of the musculature which is indispensable for the return of articular function and atrophy of the bony skeleton inasmuch as decalcification of bone is favored by lack of sun accentuated in this case by the toxic decalcification of tuberculosis. We have replaced the fixed

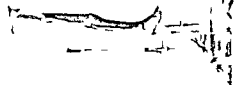


C

F l R t f p t t w th tub  
c l t sh m r to f th t bul m pe  
f t on f th t b l m f lt p to B Cu d  
th t ab cul r tru t form arm ba b t



B



D

l ad nd m ll p l C Ph to apl f pat nt hown  
h th att d M d f ct D Sam p t t to  
ft ) p p l c t n f t app r tus cured

plaster shell by orthopedic appliances of great simplicity of which the main principle is the free access of sun to the diseased regions thus aiding the local defense without hampering the general treatment

For hip disease just as for Pott's disease the correct arrangement of the bed is the touchstone of orthopedic treatment. The mattress should be flat and of hard material sufficiently resistant to avoid forming hollows under the pressure of the body as a soft mattress into which the body sinks prevents normal evaporation of sweat favors the maceration of the skin and the formation of bed sore. It may also cause faulty position.

The bed we use is of metal with an under frame of steel plate. It is furnished with wheels to allow of its being rolled on to the gallery and is sufficiently high to facilitate the careful control of the position of the pelvis and the extension apparatus and at the same time permit of free exposure to the sun. A millet seed cushion is placed on the hard mattress to raise the pelvis a very important

point in the treatment. This raised position while steadying the pelvis facilitates perfect exposure to the sun of the coxofemoral region. It is further largely instrumental in preventing flexion and adduction deformities or in correcting them if already present on arrival. Continuous extension of the leg on the diseased side is an absolute rule of treatment. Its object is to hold apart by axial traction the articular surfaces so as to prevent friction and adhesion with contact contamination of the opposing surfaces. By this separation of the articular surfaces it helps the analgesic action of the sun. The extension should pull from the thigh to avoid distension of the knee joint. Formerly we used manchettes or cuffs made of leather attached one above the knee and one at the ankle and joined by leather straps to which the extension weights were slung. These cuffs however were found to have a slight tendency to atrophy the muscle and we have now replaced them with long strips of sticking plaster reaching up to the trochanter

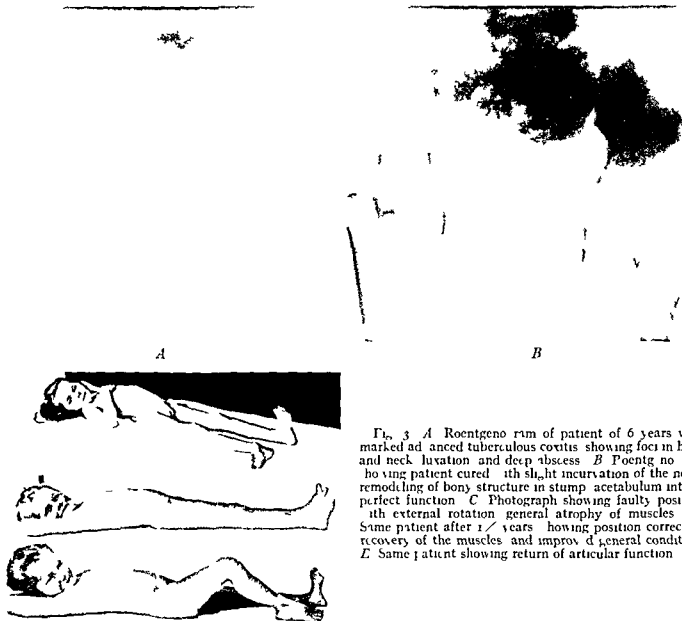


FIG. 3. A Roentgenogram of patient of 6 years with marked advanced tuberculous coxitis showing focus in head and neck luxation and deep abscess B Roentgenogram showing patient cured with slight incurvation of the neck remodeling of bony structure in stump acetabulum intact perfect function C Photograph showing faulty position with external rotation general atrophy of muscles D Same patient after 1 year showing position corrected recovery of the muscles and improved general condition E Same patient showing return of articular function

To facilitate the extension and to get the full unhindered pull of the weight applied we use a back splint of aluminium or perforated celluloid on which the leg rests. This is posed on a fixed static and is fitted with small wheels which run in grooves. We thus avoid the friction of the heel on the bed and the extension loses none of its force. When the pelvis is tilted extension is applied to the other leg thus re-establishing the equilibrium. Where combined abduction and extension is required we use an apparatus in which the aluminium back splint with its static is in turn posed on another static on which it is freely movable in a lateral direction. By applying a lateral weight extension to the back splint abduction is thus combined with extension. In some cases in which deviation is very marked a rubber tube padded with gauze is passed through

the opposite groin and the two ends fixed to a pulley extension at the top corner of the bed.

In many cases of hip disease the malposition of the hip joint is accompanied by a tendency to equinism of the foot. To combat this we use a special sandal with a wide sole which is fixed over the instep two elastic bands running from the toe of the sandal to above the knee are put more or less on the stretch according to the degree of equinism. This apparatus in no way interferes with the mobility of the foot which it gradually brings back to correct position. For children and restless adults it is advisable to apply a thoracic brace of strong canvas which acts as a counter extension and insures a more complete immobilization. It is fitted with shoulder straps and buckles. This brace which can easily be opened to allow of general insolation is firmly fixed to the



I 4 1 k t m l l f h d p d  
f l t l u h j f t t l m t m l l p l  
m k t t p l y i l t r u t f d l d l l  
f t b l v t t h l n f t b M  
g l l f t l t l l m m d l f t h t u m p

v t h e t u t m c l e i f d t r u c t o m m u t t  
t l n l l p l t m l l C h t a p h o f p a t t  
d d t l l E S m p a t n t f t z m t h s  
l t d t k m j m t f t h g e r a l c o  
d t d l p t l t r n f f u t

bed. It is applied as a general rule to all children suffering from hip disease. If it is considered necessary, the pelvis can be more securely immobilized and at the same time undue pressure on the abdomen avoided by means of a simple broad elastic band passed round the hips and faced at the side. Straps furnished with buckles fix this band to the two sides of the bed and thus assure strict immobilization and satisfactory equilibrium of the pelvis.

One of the first results of the sun bath in association with a rational orthopedic technique is the disappearance of pain which manifests itself after a short time. Even after the first few days

it is well known that the famous "cavities cry" is heard no more. This analgesic action must be attributed to the decongestive action of the sun on the deeper regions, aided as we have seen above by the extension of the leg. Improvement of the general condition of the nervous system and of the whole organic resistance under the influence of the sun and air bath also contributes largely to the diminution of pain. One must never forget that the patient's morale is a very so important a factor in the cure. A powerful stimulant by the marvellous sensation of well-being which the daily practice of the sun and air bath produces. We are often spectators of a real

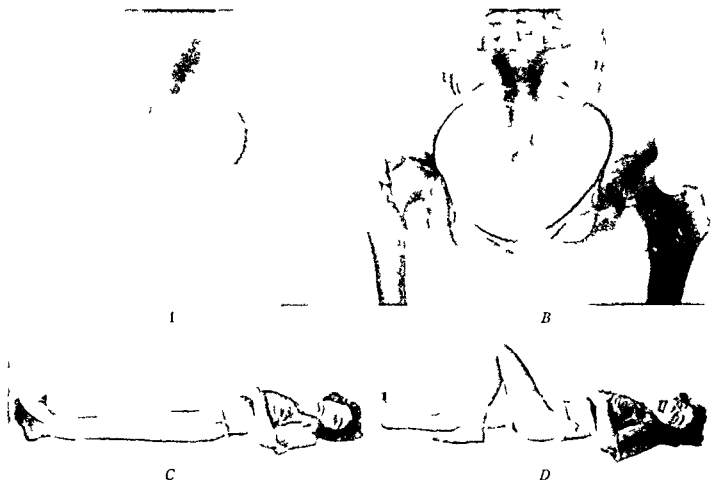


FIG. 5. A Roentgenogram showing erosion of the acetabulum contours of the head and of the acetabulum eroded enormous atrophy in tuberculous coxitis with

in B Appearance of trabecular structure complete demarcation interarticular space clear C Photograph of patient D Normal function after 6 months

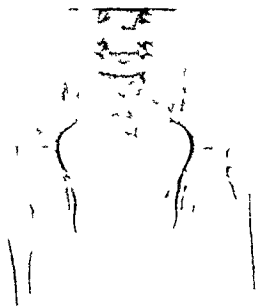
psychical renaissance in our cases of surgical tuberculosis and among them the sufferers from hip disease. This reaction certainly hastens the progress of the cure and forms a valuable aid for the doctor who must in all such chronic troubles combine a knowledge of psychotherapeutics with his other attainments.

Another precious aid for the morale of the patients is the work cure which can be practiced regardless of the weather and which experience has taught us to value as a real therapeutic agent. In the profound conviction that rigorous and complete immobilization is an error prejudicial to the organic defenses we sought by introducing a progressive course of manual work strictly individualized to develop the specific resistance of each patient contemporaneously with his general resistance.

It may seem somewhat paradoxical at the first glance to propose manual work for cases of surgical tuberculosis often seriously ill and always confined to bed. Our experience however has been that graduated regular work under medical control has never in the least hindered the pro-

gress of the cure. On the contrary it is a real help for cases of hip disease. A special apparatus enables the patients to work lying on the back without any danger of the least unsuitable movement of the hip joint which is held by the running extension. They can thus easily learn weaving, fillet, crochet, painting on wood or on porcelain while patients with Pott's disease in the ventral position are able to undertake wood cutting, box and basket making, typewriting and the manufacture of minor mechanical objects. The advantages of this work cure when carried out systematically are indisputable: it is the most powerful antagonist of boredom—the common danger in all chronic diseases and it provides poorer patients with an appreciable financial aid. A tuberculous subject once capable of undertaking remunerative work loses the depressing feeling of uselessness, regains a sense of his social worth and thus enters on the first stage of his return to normal life.

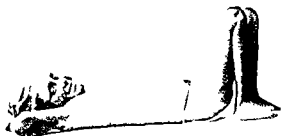
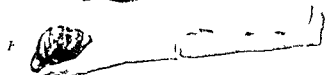
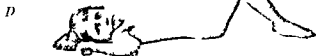
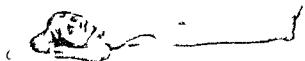
As soon as the clinical and radiological condition of the hip joints permits of moderate mobilization without fear of accident the patients are



A



B



F 6 A R t no ram h n di a full  
t ty ad a d d trut n l fh ad nd nck l  
t n o th d pphy alf d pab  
f b l t alt b ul t B C mpt t t f th  
l s d s l d t a b ul t ruct e d ry t

fat v d m t n f th ma n b C Ph t  
g ph of p t e t n l how m led compensatory  
l rd D O al nc mpt t e f u c t i o n E C d a l  
t t F Ph t g a p h t sh w e mpt t r e t u r n o f  
f t u o G Sh d u b l e t n a p p r a t

placed in the ventral position for a part of the sun bath. A wedgeshaped cushion is placed under the thorax and another under the feet to avoid excessive traction on the toes. The ventral position does not exclude the maintenance of extension and it has the great advantage of allowing exposure of the whole body to the sun, particularly the thigh regions and thus helping the development of the musculature. Often a real muscular regeneration is the result. The quadri-

ceps is often degenerated to mere strips and the gluteal mass completely flattened out, inelastic and bereft of all power, regain a form and size approaching the normal. As the circulation becomes more active and intense under the action of the sun and with the renewed participation of the integuments in the circle of local metabolism so the muscle recovers their tone and elasticity and contribute to the return of articular function. This return of function as we have



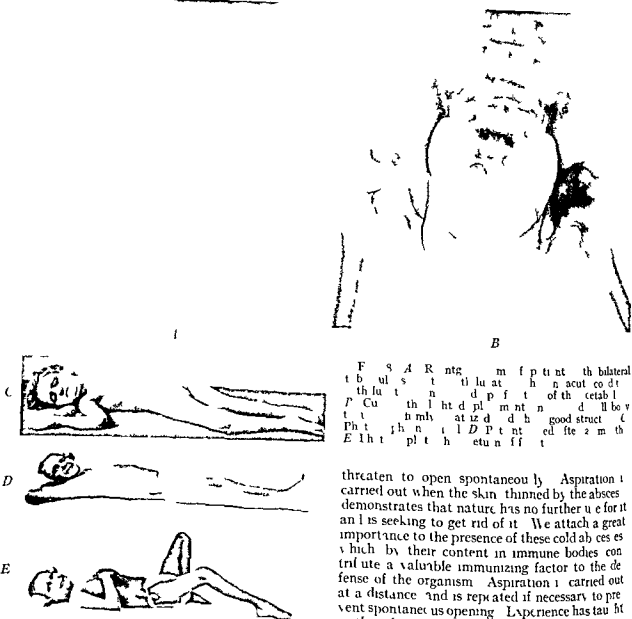
Fig. 1. A Roentgenogram of patient with tuberculous arthritis showing luxation after migration of the acetabulum head of femur completely displaced forms indefinite cloudy mass B Roentgenogram showing readaptation of head to the displaced acetabulum which is firmly sclerosed C Photograph of patient showing vicious attitude of the disease neglected D Cured after 2 years E Complete return of function

Professor Koch of Berne whose assistant I had the honor of being for 4 years I was surprised and somewhat disturbed to see return of function following cure by heliotherapy I was however reassured by the examination of X-ray films showing a magnificent bony reconstitution of the affected articulations and later we were able to convince ourselves that hip disease cured by heliotherapy with recovered movement had much less tendency to relapse than when cured with ankylosis In the beginning this return of mobility seemed to us so abnormal and uncertain that we thought it necessary to fix the healed joint with an unjointed celluloid apparatus This we soon abandoned realizing on the one hand that the apparatus tended to atrophy the fine musculature of our hip cases and on the other hand that the return of function was both solid and durable One must attribute this mobility to a combination of the following factors the improvement of the circulation and of the local defense under the action of the sun the building up of the musculature which is stimulated to more active metabolism by the actinic rays and which thus reacts much more easily on the bony levers as soon as the joint is capable of movement and finally to our system of orthopedics which by condemning

already pointed out is quite common in the cure of hip disease by heliotherapy It is however always spontaneous we never allow active movement of the joint by the patient nor do we ever attempt passive movements To nature belongs the task of restoring function so far as she judges it possible and free from danger The beginnings of movement are seen during treatment and develop *pari passu* with the progress of cure But only after the X-ray has demonstrated the cicatrization of the bone do we allow the patient to try occasional flexion movements which improve the circulation and strengthen the muscles By daily repetition of these small flexion movements one helps the restoration of mobility to the joint in so far as the anatomical condition permits

I must admit that in the early years at Leysin impregnated with the teaching of my master

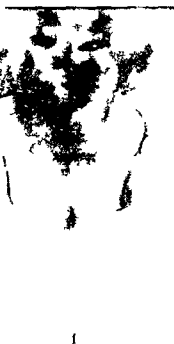




the plaster cast eliminated straight off the principal cause of functional impotence. In addition heliotherapy by diminishing the frequency of abscesses and their complications the secondary inflammatory reactions e.g. oedema, sclerosis and thickening of the soft parts, vascular atrophy, etc. provides a further aid to the return of articular function. Treatment of hip disease by heliotherapy is most successful when the lesion is a closed one. In the presence of a cold abscess contrary to the generally accepted practice we are in no hurry to aspirate. We wait as long as possible i.e. as long as the abscess does not

threaten to open spontaneously. Aspiration is carried out when the skin thinned by the abscess demonstrates that nature has no further use for it and is seeking to get rid of it. We attach a great importance to the presence of these cold abscesses which by their content in immune bodies contribute a valuable immunizing factor to the defense of the organism. Aspiration is carried out at a distance and is repeated if necessary to prevent spontaneous opening. Experience has taught us that the complication of mixed infection completely reverses the favorable prognosis of closed hip disease. And for this reason we insist on conservative treatment of this localization which avoids transforming a closed into an open tuberculous lesion.

In fistulous hip disease the essential condition for cure is above all to assure good drainage. If the tract is well drained the sinuses dry up *pari passu* with the improvement of the general condition. If on the other hand drainage is insufficient periods of retention are frequently accompanied by high temperature, discomfort, anorexia and pain all of which have their effect on the general health. When these attacks are followed



1



B



C



E

Fig. 4. Roentgenogram of patient with severe tuberculous coxitis with union showing melting of all articular structure perforation of acetabulum and large abscess around the articulation. B. The whole articulation is

strengthened and calcitrated and readapted to almost normal function with a strong bony partition as point of support. C and D. Condition of patient on arrival. E and F. Patient cured after 3 years. G. Showing return of function.

as it is often the case by a pus debacle recovery is rapid. This is however not so when the pus is incompletely evacuated and remaining in the tissues causes serious intoxication which may ultimately lead to amyloid degeneration. To prevent an inopportune closure of the sinus openings with the danger of retention the sun is applied in small doses and damp compresses are afterward laid on. In the sinuses with a deep track a wick of sterile gauze is inserted or laminates to prevent premature closure. Generally the sun by virtue of its strongly detergent and eliminative action tends at first to increase suppuration. It then diminishes becomes sero-

purulent serous and finally dries up altogether when the general and local condition is sufficiently restored. In some serious cases of fistulous hip disease with multiple sinuses and deep abscesses the procedure indicated is not sufficient to prevent retention inasmuch as the horizontal position impedes the drainage through openings situated in front or often even in the iliac fossæ. To facilitate drainage in such exceptional cases only we feel justified in allowing the patients to get up before complete cure of the bony lesion and we permit them a little graduated exercise on crutches. In such cases the bad leg hangs freely without the aid of any supporting appara-

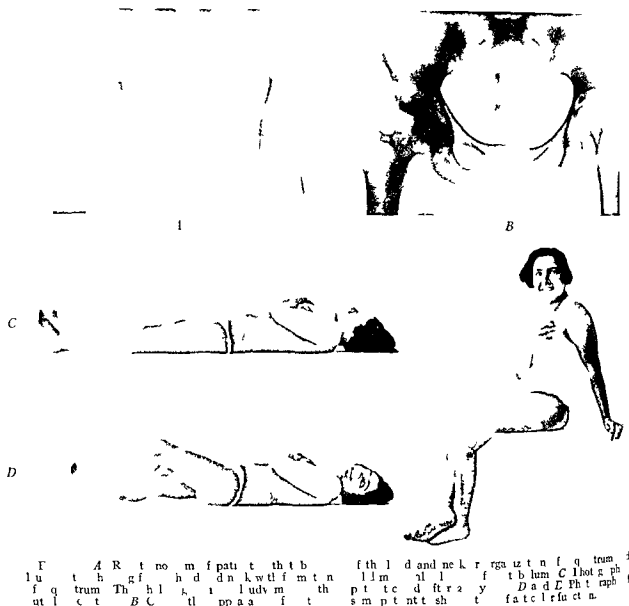


FIG. 1. A. R. t. no. m. f. pati. t. th. t. b. l. u. t. h. g. f. h. d. d. n. k. w. t. f. m. t. n. f. q. trum. Th. h. l. k. t. l. u. d. v. m. th. ut. l. c. t. B. C. tl. pp. a. a. f. t.

f. th. l. d. and ne. k. r. r. ga. u. t. n. f. q. trum. f. l. l. m. al. l. f. t. b. lum. C. l. hot. g. ph. p. t. t. c. d. f. tr. a. y. D. a. d. E. Ph. t. raph. f. s. m. p. t. n. t. sh. t. f. a. t. c. l. r. f. a. c. t. n.

tus which might cause pain or impede the circulation and the sound foot is raised in an orthopedic boot. We have often succeeded by this change in facilitating the evacuation of pus, recovery from intoxication, return to a regular temperature curve and consecutive improvement of the general and local condition. As a general rule we do not allow our cases of hip disease up until X-ray examination confirming clinical findings has demonstrated complete sclerosis of the lesions.

Some 50,000 X-ray films have been taken here since the beginning of our work and we have had ample opportunity to observe that no bony lesion however deep escapes the influence of the solar

rays. In hip disease bony reparation and reconstitution occur in the following way. We commonly see tuberculous cases in full activity with the acetabulum the head and even the neck of the femur showing the signs of extensive melting represented on the film by the well known fog which obliterates the contours of the joint. In this chaos a new head gradually reappears of which the outlines at first confused and cloudy become gradually more precise and regular. The demarcation zone becomes clearer and the decalcified regions are the seat of intense recalcification. In other cases in which the femoral head had burst through the caseation floor of the acetabulum the X-ray films demonstrate recon-

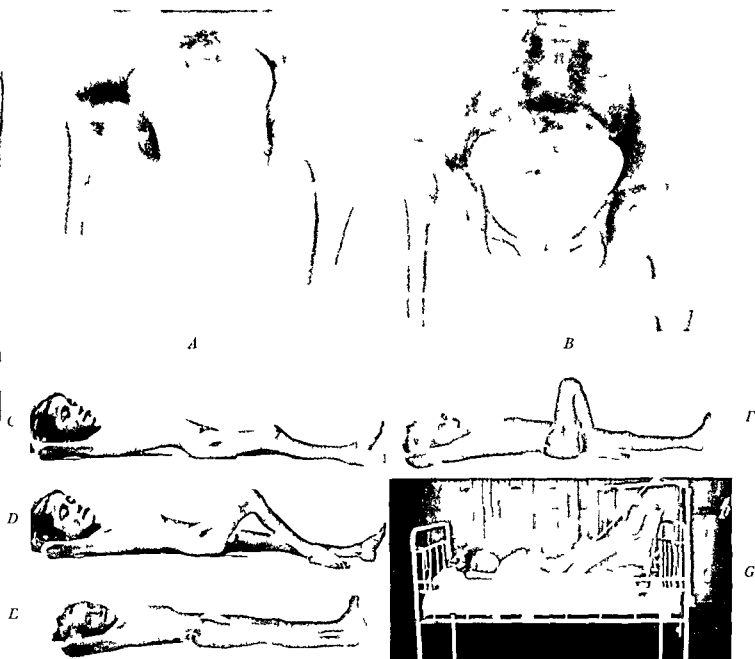


Fig. 11. 1. Poent enogram of patient with acute tuberculous coxitis showing luxation after destruction and loss of head and neck. The whole joint is damaged and shows no clear structure. B. Partial correction of the vicious attitude. Solid reparation of the floor of the acetabulum. General recalcification. C. Photograph of patient showing bad general condition muscular atrophy. D. On arrival. E. Patient cured after 12 months. F. Showing the return of articular function. G. Our apparatus of extension on an inclined plane.

struction by stages a strong partition of rough structure is first laid down which then becomes compact and regular a new articular cavity is formed firm and delimited allowing a functional adaptation of the new femoral head to an often unhelped for degree. Once the bony cicatrization is complete clinically and radiologically the period of training for the vertical position and for exercise begins. Prudent graduation is naturally essential with the ordinary precautions. The legs are bandaged with elastic bandages to prevent

abrupt dilatation of the venous network. orthopedic insoles are placed in the shoes to support the plantar arch and avoid flatfoot etc. As regards the celluloid apparatus which we formerly used to support the hip joint experience has gradually led us to abandon it in most cases. Cases of hip joint tuberculosis cured by heliotherapy are generally provided with such a solid muscle scaffolding that a supporting apparatus is quite superfluous. The patient should not use crutches when beginning to walk as they have a



A

B

C

D

Γ t l P t m f p t t th t b l  
t l t l p ty f t f tr l t t  
l d f tl f m Th t b l m full d th f  
g m B C pp f tl mf f

tl h a l th f m tru t S t f t r l no f  
th ac t b l m b l C Ph t raph f p t n t ur d  
alt y D S m pat t h i th t m t  
t l f ct

tendency to deform the spine ordinary long sticks held at the shoulder level so as to expand the chest are useful in our clinics

The results obtained by heliotherapy are I believe conclusive and a careful study of the appended roentgenograms will enable any one to come to the same conclusion. The results are a proof of our contention that heliotherapy may be considered as the ideal conservative treatment for tuberculous hip disease. The treatment has in addition a considerable social value. By avoiding mutilating operations and developing a

splendid musculature it retains in most cases the articular function in its integrity and gives back to the body a symmetrical harmony. To sum up it enables us to give back to society normal beings splendidly fit capable of working for their living

No E—D t l d c l c l d of a f h p d c c  
t b f d th th f m y l d tant D yod  
h t l t l d H é l o t h é r p d l l t  
l t s (U n i t y of I a u 9 6) a d P  
M ill wh t l t l d Et d d l a f n t  
a t c l a d th t t b e l u e t r t é p l H é  
th rap F r m p c i d t a l c c h h  
th p y n g e r l m y b o o k o n H l th rapy p b b h e d  
by O f d d d t m y b f a l

FROM THE DIVISION OF SURGICAL MEDICINE

## TECHNIQUE OF REMOVAL OF CYSTS AND SINUSES OF THE THYROGLOSSAL DUCT

BY WALTER E. SISTRUNK, M.D., IACS, ROCHESTER, MINNESOTA

TO operate satisfactorily for the removal of cysts or sinus tracts of the thyroglossal duct a surgeon should thoroughly understand the mode of development of such cysts and possess accurate knowledge of the anatomy of the base of the tongue and surrounding structures.

Early in fetal life before the hyoid bone develops the thyroid gland appears at the base of the tongue and descends in the median line of the neck. In normal individual the epithelium lined tract produced by the descent obliterates; if obliteration fails to occur completely the secretion produced by the epithelial tract probably empties through the foramen cecum into the mouth. Should this opening into the mouth lose its patency through inflammatory or obliterative changes the secretion works downward along the tract through which the thyroid gland has descended and produces a cystic tumor in the median line of the neck, usually at a point about midway between the hyoid bone and the top of the thyroid cartilage. The cysts, after passing

downward below the hyoid bone, become superficial and lie beneath the raphe joining the sterno-hyoid muscles and the thyroid cartilage; they occasionally descend as low as the sternal notch but are always found lying in the median line or very close to it, thus differing from branchial cysts or sinus tracts which are always lateral to the median line.

Should a sinus tract be present it should be injected with a weak solution of methylene blue in order to outline its course definitely. Under general anesthesia with the patient in the usual position for performing thyroidectomy, a transverse incision 5 or 6 centimeters long is made over the cyst through the skin, subcutaneous tissues and platysma muscle (Figs. 1 and 2). The cyst or sinus tract will be found lying under the raphe joining the sterno-hyoid muscles. This raphe is cut longitudinally and the cyst dissected free from its attachments up to the hyoid bone. The tract usually passes underneath this bone

Loc 1 x th m y b sc f l d  
Th m l th t p g f p t m y b  
m l

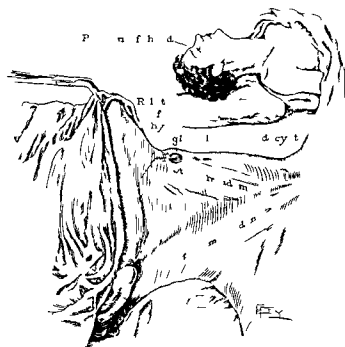


Fig. 1. Cyst and tract in relation to muscle and hyoid bone. Insert shows position of head for thyroglossal duct operation.

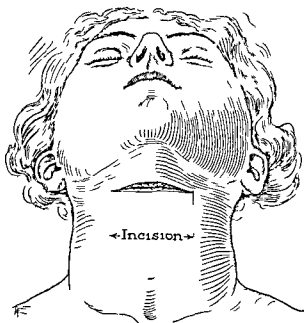
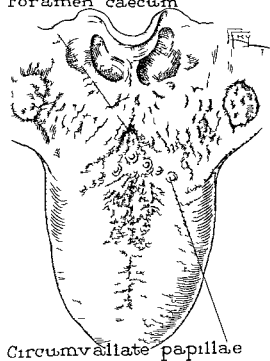


Fig. 2. Position of incision.

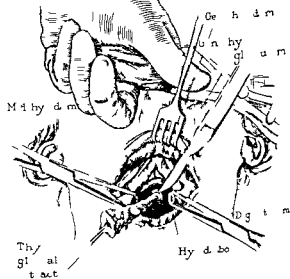


F h 4 I g i m the l t g t c t

## Foramen caecum



H 3 P tio ffo m x m



I 5 C t t f i n d f t a t

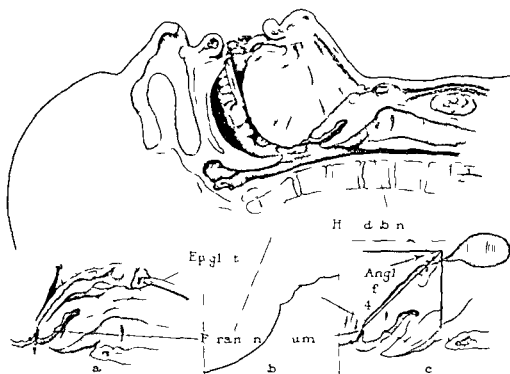


FIG 6 a Dissection of tract down to mucous membrane b Position of tract c Angle of tract

but may pass superficial to it or through it. In order to remove the duct completely at this point a small segment or 3 millimeters in diameter is removed from the center of the hyoid bone. The mouth is then held open with a gag and the tongue pulled forward with a suture or small stomach forceps. The index finger of the left hand is introduced into the mouth and the foramen cæcum located by palpation (or inspection). This may be done by following the two rows of circumvallate papillæ one of which lies on each side of the tongue backward to the point where they join in the median line. The foramen cæcum lies just posterior to this point (Fig 3). This is pushed forward and upward with the finger in order to shorten the distance between it and the hyoid bone (Fig 4). Then without an attempt to isolate the duct the duct and the tissues surrounding it for a distance of about 3 millimeters on all sides are coiled out through the muscles of the tongue to the mucous membrane at the foramen cæcum where they are cut off without opening the mucous membrane of the mouth (Fig 5). In doing this it is necessary to bear in mind the direction of the thyroglossal duct. With the patient in the position suggested this corresponds to a line drawn at an angle of 45 degrees backward and downward toward the foramen cæcum through the intersection of lines drawn horizontally and perpendicularly to the

center of the hyoid bone that is it corresponds to a line drawn from the center of the hyoid bone to the foramen cæcum (Fig 6).

In temporarily disregarding the duct and coring out the tissues through which it passes lies

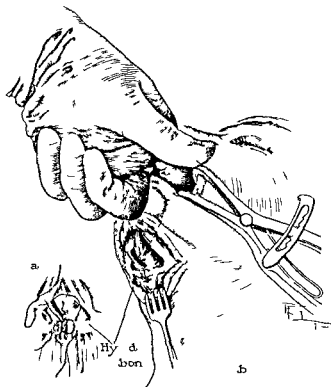


Fig 7 Suturing end of hyoid bone together





Fig. 5. Wound closed by interrupted sutures. It is also how the duct is

one of the secrets of cure as the duct is so small and delicate that it is almost invariably broken and retracts and is lost if efforts are made to direct it out alone. The finger in the mouth serves as an excellent guide to prevent entrance through the hyo epiglottic fold into the mouth or into the pharynx.

In dissecting out the duct a portion of the hyoid bone, portions of the raphe of the mylohyoid muscle and portions of the geniohyoid and geniohyoglossus muscles are removed.

The opening through the muscles of the tongue is closed with several interrupted catgut sutures placed superficially through the muscle of the

tongue (in order to avoid the hypoglossal nerve) and the edges of the hyoid bone are brought into apposition with one or two chromic catgut sutures taken through the periosteum of the bone and tissues adjacent to its cut end (Fig. 7). A small rubber tube is introduced deeply into the muscle of the tongue and is allowed to remain for 4 or 5 days. The skin wound is closed with interrupted dermal or horse hair suture (Fig. 8).

No harm has resulted in a large group of cases by removal of a small segment of the hyoid bone and following such an operation properly performed practically 100 per cent of the patients are cured.

## REPAIR OF INTERNAL RING IN OBLIQUE INGUINAL HERNIA

BY F. GILCOLY CONNELL, M.D., OMAHA, WIS.

THE internal or abdominal inguinal ring is the landmark that distinguishes the two types of inguinal hernia. In the indirect or oblique the sac passes through the internal ring in the direct which is practically a ventral hernia in the inguinal region the sac passes not through but below the internal ring (Fig. 1).

With large indirect or oblique inguinal hernia the internal ring may be dilated to such a degree that its lower margin approaches the pubic arch. Under the circumstances there is still an anatomical distinction but little practical difference between oblique and direct hernia and a plastic repair similar to that for direct hernia is indicated.

The internal ring may be likened to the keystone of the arch in nature's architecture of the inguinal canal. Under normal circumstances this structure helps to prevent the protrusion of viscera through the inguinal canal. It is situated at the entrance to the inguinal canal and one may reasonably suppose that if this structure is normal in its relationships, contents, size and position indirect hernia would rarely develop. The size, position and relations of this internal ring determine the length, obliquity and character of the walls of the inguinal canal, all of which are important in nature's method of preventing the development of oblique hernia.

If small the internal ring is high which means the canal is long and oblique; its lower border and the posterior wall of the canal are strong, firm, tense, composed of transversalis fascia reinforced by the ligamentum interfoveolare of Hesselbach and the anterior wall of the canal is composed of red internal oblique muscle and external oblique aponeurosis. On the other hand if the ring is large it is low and wide which

means that the canal is short and straight; its lower border and the posterior wall of the canal are weak, relaxed and often are absent, and the anterior wall is composed of only the external oblique aponeurosis.

The relationships shown in parallel columns as follows:

## INTERNAL OF ABDOMINAL INGUINAL RING

	Normal	Abnormal (hernia)
Abdominal aspect	Smooth parietal peritoneum	Bulging parietal peritoneum hernial sac Abnormal (hernia)
Cutaneous aspect	Normal Internal oblique muscle	External oblique aponeurosis (Internal oblique above internal ring and sac)
Superior margin	Transversalis fascia	Same
Inferior margin	Transversalis fascia reinforced by fold of the ligamentum interfoveolare	Same but inferior margin may be depressed to pubic bone depending upon contents of sac
Contents	Cord only or cord and preformed sac	Cord, sac and content of sac
Size and position	Small and high	Dilated and inferior margin lower

As the abnormal internal ring allows the protrusion of the sac or the filling of a preformed sac and the sudden or gradual development of a hernia the normality or abnormality of the internal abdominal ring is followed by normality or abnormality of the inguinal canal.

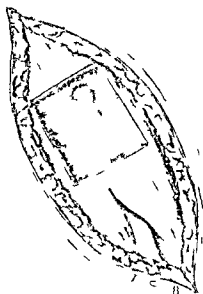
The normal inguinal canal is long, oblique, narrow and contains no sac; the internal ring is high, small, it snugly surrounds the cord and is covered externally by the internal oblique muscle (active muscular check at entrance of canal) and the external ring is low, small and triangular.

The hernial inguinal canal is short, straight, wide and contains the sac which often extends to the scrotum; the internal ring is lower, dilated and is not covered externally by internal oblique muscle and the external ring is dilated upward and rounded.

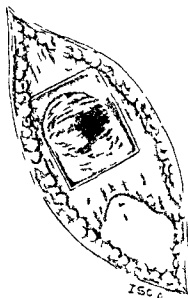
These relationships are shown in parallel columns as follows:



FIG. 1. Showing an oblique and a direct hernia. 1 Oblique hernia, 2 direct hernia, 3 intra-abdominal inguinal fossa, 4 external inguinal ring, 5 external inguinal fossa, 6 external inguinal ring, 7 intra-abdominal fossa, 8 internal oblique muscle and transversalis, 9 aponeurosis of the external oblique. (From von Bergmann 4.)



Normal trial



F<sub>3</sub> Abn m l t n l m obl qu g n l t m

P pe l s th m l Obl I l  
 I f sc sal d t t l g W k l d  
 I g l g H h m ll d g D l t l d d l y d l  
 th d d g l d m g N d d b  
 h m t b h m y b l w  
 I t l I t l d I b d d l I lly l b g  
 m bl q d doe h d doe g  
 E t al C bl q m l C t l C t l d  
 bl q d l d d d d  
 E l S ll t m ts g l d D l i p w d d D l d p d d  
 g l m ts d d f m ts d m d l

2. Reconstruction of the inguinal canal along anatomical lines based upon knowledge of the normal and pathological anatomy and physiology, which must of necessity vary with the type of hernia.

### 3 Primary wound healing

3. Primary wound healing  
The first and third seem practically easy to attain but the second is not so simple. Much consideration has been given to the wall of the canal and the external ring but the importance of the internal ring seems to have been given little serious attention. To be sure a new abnormal internal ring is constructed in the Bahr operation its various modifications and in other plastic operative cures for inguinal hernia but the importance of the normal internal ring in its relations and the advisability of reconstruction imitating the normal characteristics of this opening has been scarcely emphasized.

The method of Bassini has become almost a standardized procedure in repair of a unilateral hernia but its result is not anatomical in that the red internal oblique muscle is placed around and below the internal ring instead of covering it superficially as it does under normal conditions.

This Bassini repair has been much modified by E. Wyllys Andrews Iergu on Halsted Woelfler Gerard Fowler and others and more recently by Bates Harri on Kerby Slatterly Downe Schley Stetton Lyle Edmund Andrews Pitman Seelig and others

Direct hernia will not be considered at this time

### TRI ATMENT

Given a man with oblique inguinal hernia on one side and normal inguinal relations hips on the other as outlined above what could be more rational in an attempt at repair of the hernia than to replace in the normal relationships the various structure on the hernia side.

The essential for the repair of oblique inguinal hernia seem to be

- 1 The removal of the entire sac

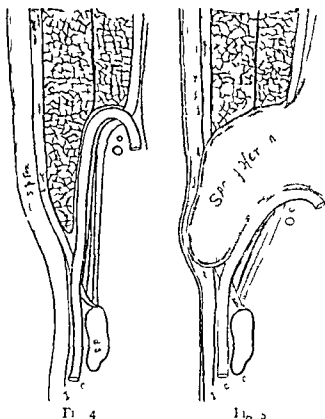


Fig. 4 Normal inguinal canal  
Fig. 5 Abnormal inguinal canal oblique inguinal hernia

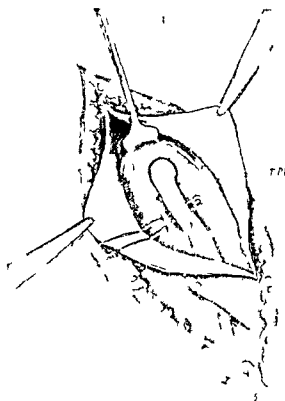


Fig. 6 Repair of internal ring (from Gregory Connell 1906)

Seelig in 1903 caused considerable controversy by claiming that fascia and muscle would not unite but Koontz in 1906 was unable to confirm Seelig's findings. In 1907 Seelig in an article entitled *Fundamental Principles Underlying the Operative Cure of Inguinal Hernia* finds that fascia will unite with epimysium, perimysium and endomysium (the connective tissue covering and between the muscle) and that traumatized muscle because of the exposure of the fibrous tissue trabeculae will unite satisfactorily with tendon and aponeurosis.

After the proper reconstruction of the internal ring, suture of the internal oblique muscle to Poupart's ligament is rarely indicated because the muscle will without suture cover the ring.

The normal relationship may be re-established by elevation of the ring to a position behind the muscle or depression of muscle in front of the ring.

The former is much more satisfactory, but if in larger hernia simple elevation of the ring is not sufficient the muscle after traumatizing may be sutured to the outer half of Poupart's ligament with reason to anticipate union.

In the direct or the large indirect hernia with relaxed abdominal walls and obliterated or absent conjoint tendons and transversalis fascia in

which satisfactory sutures require so much tension as to defeat their purpose a plastic operation preferably with transplantation of living tissue will be called for but such plastic operations do not change the underlying principles of the attempt made to correct the abnormal inguinal anatomy.

Koontz finds that heterogenous fascia may be used satisfactorily and such fascia is promised for the general market.

The transplantation of free flaps of fascia lata (as advocated by Kirschner 1909) has been successful in repair of hernial defects but has now been largely superseded by the modification of Gallie and Le Mesurier in which the fascia transplant is cut in narrow strips and the defect repaired by a darning or interweaving process. This gives much more marginal contact and therefore more likelihood of survival. Such transplantation of tissue is called for in large defects and often after previous attempts at cure.

The imbrication of the external oblique aponeurosis in the method of E. Wyllys Andrews is in effect a fascia transplant as is MacArthur's



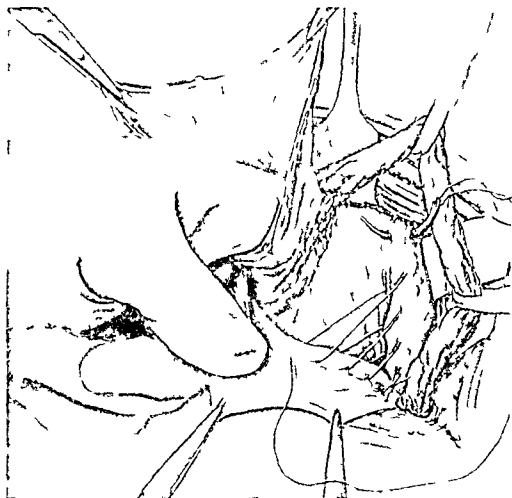


Fig. 8. Repair of internal ring as done by Edmund Andrews (2).

direct hernia or pantaloon sac with finger in peritoneal cavity.

5 Reconstruct the internal ring and posterior wall of the canal ring to be minimized and elevated by repair of the transversalis fascia below the cord which may be carried out in accordance with the method of Gregory Connell 1909 (Fig 6) or that of Marsh Pitzman 1921 (Fig 7) or that of Edmund Andrews 1914 (Fig 8) or that of Major Seelig 1917 (Fig 9). If the transversalis fascia or the posterior wall of the inguinal canal is markedly attenuated some type of plastic operation will be indicated such as the method of Parks (utilization of thick sac wall as suture material) of Wyllis Andrews (imbrication of external oblique aponeurosis) of Mac Arthur (the use of strips of external oblique aponeurosis as suture material) or of Gallie and Le Mesurier (darning defect with strips of free fascia transplant).

6 Remove sac high up leaving no redundant parietal peritoneum to pouch outward as a potential sac. Close neck by suture not a simple circular ligature. Suture of internal oblique

muscle to Poupart's ligament is rarely necessary as the internal ring is elevated and usually placed behind the internal oblique muscle.

7 Reconstruct the anterior wall of the canal by suture of the divided external oblique aponeurosis by imbrication or not according to the extent of relaxation.

8 Reconstruct the external (subcutaneous) ring from above downward in this way increasing the obliquity and length of the canal.

9 Close of fascia and skin.

Because of a multitude of variable factors statistics are many times misleading and are notoriously unreliable but Pitzman has well said:

If the theory of this operation is better *ipso facto* the practical result will be better. The result in the individual case may depend upon circumstances other than the method of operative repair such as sex, occupation, age, physical condition, the size and contents of the sac, the accurate differentiation between direct and indirect types, upon technical errors or faults such as failure to remove all of the sac or to recognize a double or pantaloon sac or to remove dilated

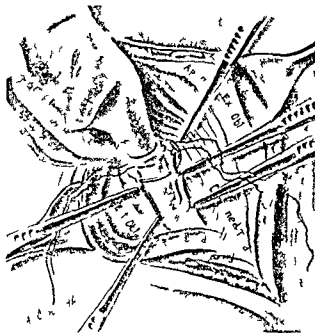


FIG. 1. Repair of internal inguinal hernia (Major S. I. Arh. 1933)

veins or fat upon injury to nerve placing stitches under too great tension or upon postoperative complications or accidents. But the most important cause of recurrence is probably the failure to establish the correct relationship between the type of hernia and the character of the operative technique in the individual case e.g. utilizing one method as a routine in all cases of inguinal hernia.

Published statistics show a great variety in the percentage of recurrences after attempt at repair

from less than 1 per cent to 10 per cent for indirect and from 14 per cent to 5 per cent for direct.

Personal cases in the service of Dr. C. J. Combs and myself show with transplantation of the cord 100 sutures of internal oblique muscle under cord 137 cases traced with 8 recurrences 5.8 per cent without transplantation of the cord 100 in which the internal oblique muscle is not sutured under the cord 162 cases traced with 4 recurrences 2.46 per cent.

As in all statistics these figures are likewise misleading in that the early simple small herniae are in the more favorable group while the late complicated and larger cases are in the less satisfactory group.

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## LEAD TREATMENT OF CANCER

By H J ULI MANN M.D. SANTA BARBARA CALIFORNIA  
 D i t t h D p t m t f C c R h t B k C t t g H p t I

WE have presented evidence in previous publications for the use of colloidal lead orthophosphate rather than the metallic colloid in the treatment of cancer. We have shown both from animal experimentation and from clinical experience that the phosphate is much less toxic to the organism as a whole than the colloidal metal or its other salts (1-3). We believe that the solutions as generally employed are so toxic that their use is open to question and their keeping qualities are such that it would be difficult if not impossible to bring them into general use. Solutions of lead orthophosphate keep indefinitely at room temperature and apparently do not alter their toxicity with age.

As I have been using lead preparations in the treatment of cancer for less than two years it is too early for me to evaluate the method but I have seen sufficient effect on tumors especially those of the breast to feel considerable encouragement. I do not believe it should at present take the place of the time tried methods of surgery and radiation but should be reserved for those unfortunates who are beyond the reach of either. It is necessary in order to obtain the maximum benefit to combine the roentgen ray or radium with the lead injections and therefore absolutely essential that the user be not only a good clinician but a radiologist as well or be in close co operation with a competent radiologist. He must be familiar with the effects of lead and of radiation not only on the tumor but on the body as a whole and must be prepared to combat lead as well as roentgen intoxication. The majority of patients tolerate lead very well but there are some who are easily poisoned and present the most serious problem of the many involved in this method of treatment. For the present I consider it advisable to hospitalize all patients undergoing lead treatment. It is much easier in a hospital to keep them under close observation and to perform the necessary clinical laboratory work. It is much more difficult to control the diet at the home than at the hospital and the question of diet becomes more difficult as the treatment progresses. Loss of appetite is practically constant toward the end of treatment especially when radiation sickness is superimposed on lead intoxication.

From our experience I believe that the only direct contraindications to the use of the lead phosphate to be a severe anemia and perhaps lung involvement not secondary to breast carcinoma. Several deaths have occurred in our clinic from liquefaction of lung nodules following the injection of both the metallic colloid and the colloidal phosphate. These were metastatic from tumors of the liver colon and cervical glands. On the other hand lung tumors secondary to breast carcinoma have regressed without untoward symptoms. I have injected the phosphate in several instances where the kidney function as shown by the dye test was almost zero and in one instance was actually zero. No demonstrable kidney injury has been found in any instance so far following the use of the phosphate.

Our technique at present consists in hospitalizing the patient and making a careful examination both physical and laboratory. In addition to the routine examination of the urine and blood the kidney function is estimated by the dye test and blood smears are searched for stippled cells which may be found in some cases of advanced carcinoma before lead is used. The solution of colloidal lead phosphate is then injected intravenously the amount varying with the weight of the patient and the size of the tumor. I have not as yet given more than 0.7 milligrams of lead element per pound of patient net weight. The average dose has been 80 milligrams although we believe larger doses may be safe and perhaps more efficient. Our experience with the metallic colloid has left a great impression and we have been slow perhaps too much so in increasing our dose. Doctors Withers and Ranson of Denver who are using our preparation have given as high as 1.0 milligrams at each injection and have had some marked regressions and disappearances of tumors. The question of dosage is still under investigation and I believe that we will be obliged to vary it according to the type as well as size of tumor and weight of patient.

Blood counts and the search of smears for stippled cells are made at intervals and if in our opinion the fall in hæmoglobin has not been too great or there are not more than an average of one stippled cell per high power field the dose is repeated in one week. These weekly doses are repeated until from 300 to 500 milligrams usually





Fig. 3. C. I. n. f. l. d. b. 9. 1. f.



Fig. 3. C. Lu. f. l. M. J. 3. 9. 6. h.



Fig. 3. C. I. f. l. d. S. p. t. m. b. 9.

400 have been given. Radiation either radium or the roentgen ray or both is begun when from 200 to 300 milligrams have been injected but great care is taken to prevent radiation sickness. I follow the general plan I outlined several years ago to prevent this (4) and in addition do not hesitate to fractionate the dose to any degree necessary. Blood transfusions are done wherever indicated and it has been found that the general condition of the patient is a better guide to the necessity of such a procedure than the degree of anemia. It must be understood that these procedures are never rigidly adhered to but are modified as necessary in any individual case. No one should attempt the use of lead without first reading all the articles published by Bell and his associates and a thorough study of the entire book — Lead Poisoning by Aub. Fairhall, Minot and Reznikoff. The patient is given a 4 to 6 weeks rest and the treatment is repeated until a total amount of from 500 to 600 milligrams have been given. Two grams of calcium lactate and 1 quart of milk are given each 24 hours if necessary to combat symptoms of lead poisoning.

From our observations during the last 18 months I believe that the use of lead in the treat-



Fig. 4. Case. Photograph June 1, 1927. 6 months after treatment at L. U.

ment of cancer holds sufficient promise to warrant thorough investigation but the method has not been developed far enough to warrant its general use. Under the best conditions there are many disappointments and this is especially true now when the majority of patients on whom it is tried have reached a stage in their disease when nothing even if it could produce a complete cure of the cancer as such could offer hope of recovery so far as the patient himself is concerned.

Two cases are presented to illustrate the effect of lead on cancer of the breast. The first was reported at the Washington meeting of the American Medical Association (3) and is reported again because of the still further improvement of the lung metastases.

This patient was a woman 44 years old who had had a radical resection of the left breast 3 years ago for carcinoma and later subcutaneous nodule were removed on occasion. Röntgenotherapy had also been used. On December 6, 1926 there was a 7 by 14 centimeter tumor in the right breast covered by markedly erythematous skin. Above this was an axillary node about 5 centimeters in diameter. Both supraclavicular and cervical regions contained multiple nodules. The supraclavicular space on the left contained a hard tender mass approximately 4 centimeters across. There were multiple subcutaneous nodules scattered over both the anterior and posterior thorax and cutaneous nodules in the region of the operative scar some of which were about to ulcerate. There was opacification of both retinae and a slightly painful bulging of the right eyeball.



Fig. 5. Case. September 4, 1927.

There was a slight protrusion of the chin and dryness. Both lungs felt normal (Fig. 5).

Chemical analysis of the skin intra-nodally indicated a slight increase in the concentration of lead in the tumor. A primary lesion of the tumor was suggested by the fact that the region produced immediate relief with pain and swelling. A lead was completely fatal at the mid period of treatment. Radium was applied to the right breast and axilla and left supraclavicular region followed by immediate regression of the tumor. There had been a reduction in the size of the right breast and a complete disappearance of the erythema before radium was used. The subcutaneous nodule regressed and finally disappeared and metastases in the region of the carotid appeared entirely.

The change in the lung fields is particularly interesting (Fig. 6). There was a marked increase in the density and size of the tumor shadows although the patient was clinically better. This was interpreted as due to an infiltration and swelling of the tumor nodules—a lead reaction. Small doses of roentgen rays were then given over the thorax without producing the slightest general reaction. By May 3 the lungs had shown marked improvement and there was regression or disappearance of the visible tumors. The total amount of lead element used was 602 milligrams between December 2, 1926 and August 24, 1927. No further treatment is contemplated unless there is recurrence. The appearance of the lung fields on September 1 was such (Fig. 3) that taken in conjunction with the disappearance of the palpable nodules one is inclined to report disappearance of the metastases as such. The cutaneous subcutaneous and cervical nodules have disappeared. There is a flat symptomless induration found on palpation in the left supraclavicular space. The right axillary

nodule is gone and a slight diffuse rubbery in duration is all that is left of the mammary tumor. Vision in the right eye is lost but pictures can be recognized with the left and she is able to write letters and read fairly large writing and to go about town without assistance. She is gaining weight and feels well. There is no evidence of chronic plumbism.

Th e c n d p t n t g a c h r g a s 6 v a b u t I h a e f m a t o n h h l d m e t b l e t h a t h s o e s o n d h a p p a r n t h a t f t h e g a t a g T h e d p t i n f t h e t u m o r t h t t t n b v n y t a t h n s h n t e d t h h o p t a l i g h t c r y a l n d u p a c l a u l r d p a t h y l f m l l n g u l t i p p t h l f r g h t b a t c e n t m t i n d a m t t h t n c t e t h l l d u t n d u r t l d g e T h t e b e a s t r y h d a d t h e k i n i s t n b v n y d d l r d T h e a r l g e h a d l a n d n t h g h t a l l T h l f t b a t h r m a n d t h m d i l h f l d m a l b h b t r n d t t h c h t l l T h a r e l a g e n m g l a n d n t h l f t a l l T h e k n o f t h l t h t h i k i n d u a t d n d a k r d T h h i a m s l l n t n s e a n d y n t T h h a n d c a n t l c l d B a u s e f h a a n d g e n a l p h y l n d t n l a d a g e n n m a i l ( 4 m i l l m ) d I m m e d i a t r g r e i n f a l l t h t u m o o b r v d D u e t c l n s n p h t p i m d e f s a l k a n d h n t k n t h r e w a s e d u t i o f n a l y a t h d n t h i b t h b a t ( I g 4 ) B u f h e r g a d t h o f t h t u m h v t a t d t i l y S h h a n l

o c a o d e v e l i d a t o x i p y h h n t h t u v r e g i n s p d l y e e t a t i n g p t p o m f t h e t r a t m e n t n t l e r y T a s n e r l a s t d m e c h a f d a y s S i n e M a y 1 w h n t r e t m e t a s t r i d t S e p t m b 2 h h a s d a t o t l o f 4 m l l g l e d e l e m t i n t h e f m f t h p h p h a t a d b l o o d t f u n h b e g u n n o n T h h s b e a m k d h r n k g f t h t u m r ( F i 5 ) i h e w l i f t h r m t o s h a k e h n d s n l c a n l t h h a d T h s n d b l d n g u l a t t h e t a b a l e l d B e c a o f t h x t n t o f t h m h a y d t h a g f t h p t n t f h e l t t l h p f l u m t r e r e l t t h e h e f f u n a o n d i t i t o n l y p a s s t u l t l r t h y o f p o t t a l l t r a t t h f i c t f l a d t a t I t h o p d t h a t w i l l b l f t t u m o u p e t p t m f t h l d t t m e t o f a c r o u b u e q u n t p o t

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R d l o g y q 7 J  
3 I d m T h m b t w o f c l l d l l d d r a d t  
c n c e t h a p y J A m I A  
4 I d m T l m a g m t f i t p b l n r p  
t u t R d l b y D 9 4

## INTRA-ABDOMINAL TUBERCULOSIS

B. LEO DRITZKA, M.D., F.A.C.S., D.T.R., MCH, GAN.

**T**UBERCULOSIS has almost as many angles of interest as syphilis. It has its sociological, hygienic, genetic, occupational, and psychological aspects in addition to its medical and surgical phases and we can not approach it from any of these viewpoints without considering the others.

The ultimate conquest of tuberculosis and statisticians give us sound reason to believe that it will eventually become as rare in civilized countries as cholera. Will be the triumph of the hygienist and epidemiologist. The surgeon's aid in the treatment of individual cases must be regarded as only a temporary recourse, an emergency measure applied in lieu of something better. The physician should call upon the surgeon for co-operation only when the tuberculous infection is not to be reached by any other method and if surgical interference is to justify itself the postoperative treatment must be recognized as by far the most onerous aspect of the case when the tuberculosis has progressed into certain tissues.

The results obtained in tuberculous infections with direct sunlight and proper hygienic conditions have been most encouraging in recent years. If all patients could be given the treatment for an unlimited period of time, surgical treatment should really be deferred in the majority of cases of intra-abdominal tuberculosis. Unfortunately, our patients in most parts of the United States cannot be given ideal climatic conditions.

Dunn, 1924 and 1935 studied 72 cases of surgical tuberculosis of the various abdominal organs. Of this group 16 were cases of definite primary abdominal infections, so far as could be determined by examination. In other words, the respiratory organs were normal and all parts of the body excepting the affected part and the end result after surgical intervention indicated a complete recovery.

## TUBERCULOSIS OF THE PERITONEUM

Tuberculosis of the peritoneum is most common in children and young adults. In the early



Fig. 1. Tuberculosis of the caecum. Operative specimen showing terminal ileum, caecum and cecocolon. Masses of tuberculous peritonitis with obstruction and marked tuberculous enlargement of cecal lymph gland.

stages the disease has no characteristic symptoms and is therefore frequently overlooked until effusion takes place. The initial symptoms are abdominal discomfort, loss of appetite and frequent attacks of colic. The presence of these symptoms together with anæmia, loss of weight and the typically rounded abdomen should arouse the examiner's suspicion in the direction of tuberculous peritonitis. Various types are found depending apparently on the virulence of the infection and the mode of entrance.

The organisms may enter through the blood stream, the intestinal walls, through any caseous focus which may extend to the peritoneum or most frequently of all through the fallopian tubes. In most instances abdominal tuberculosis is secondary to an infection elsewhere, but this is often difficult to prove.

Macroscopically we find minute miliary tubercles on the peritoneal surfaces and in the omentum without any accumulation of fluid or exudation of fibrin. In other cases a quantity of clear or turbid fluid is present in the cavity. Usually the amount of fluid is small, but it may be found in quantities large enough to distend the abdominal cavity.

In this moist form the patient loses weight and strength rapidly. The abdomen has a characteristic paleness and the skin is silky. When the abdomen is opened a thin fluid escapes. Flakes of fibrin may escape with the fluid. The fluid having escaped the surface of the peritoneum is seen to be studded with fine tubercles. Some of the tubercles may be of considerable size. Masses of caseous mesenteric glands may now be palpable. The omentum may be greatly thickened and



Fig. 2. Tuberculosis of the ileum with tuberculous ulceration and enteritis. Young, nodular tuberculous process in the ileum, some with hemorrhagic ulceration and others with ulceration. Note the typical transverse disposition of the advanced ulceration. Autopsy showed a bilateral caseous ulceration of pulmonary tubercles with evidence of tuberculous enteritis and ulceration also localised tuberculous peritonitis of the ileum.

infiltrated. In the dry variety there is no effusion and extensive adhesions may form between the intestinal coils. Frequently a fecal fistula is present. The surrounding tissue is inflamed and the blood vessels distended.

#### TUBERCULOSIS OF THE INTESTINES

Tuberculosis is the most frequent cause of inflammatory affections of the bowel. Tuberculous lesions are rarest in the duodenum, becoming more frequent as one nears the ileocecal valve. As to the mode of entrance, except in the cases of children in which the tubercle bacilli may reach the bowel through the digestive tract, the bacilli pass



Fig. 3. Tuberculosis of the spleen. The spleen is enlarged, the capsule fibrous and thickened. There are disseminated tubercles throughout the parenchyma with occasional agglutination between tubercles. Autopsy showed a generalized miliary tuberculosis involving the spleen, liver, omentum, mesentery, small intestines and lungs. There was also a right psoas abscess with early necrosis of adjacent vertebral bodies.



Fig. 1. The stomach and its relations to the surrounding organs. The stomach is shown in its normal position, with the duodenum and the pancreas. The illustration shows the stomach in its normal position, with the duodenum and the pancreas. The stomach is shown in its normal position, with the duodenum and the pancreas.

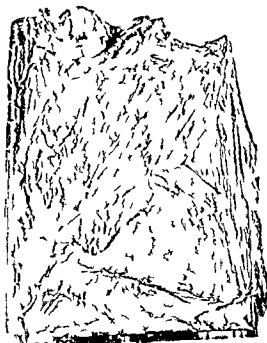


Fig. 2. The stomach and its relations to the surrounding organs. The stomach is shown in its normal position, with the duodenum and the pancreas. The illustration shows the stomach in its normal position, with the duodenum and the pancreas.

The ulcers are irregularly distributed but are usually in the region of the ileum (Fig. 1 and 2).

Acute tuberculous inflammation of the ileocolic glands often simulates appendicitis.

#### TUBERCULOSIS OF OTHER ORGANS AND GLANDS

Tuberculosis of the stomach wall or the existence of tuberculous ulcers of the stomach is comparatively rare although with the swallow of tuberculous sputum one would expect the direct opposite. The tuberculous ulcers that are found are probably primarily ordinary gastric ulcers infected by the organisms.

Tuberculosis of the gall bladder is extremely rare and simulates gall bladder diseases in general.

Tuberculosis of the liver is not uncommon but is seldom extensive and for the most part consists of minute tubercles scarcely visible. It is always secondary.

It is doubtful if tuberculosis of the spleen is ever primary. Frequently however the spleen is involved along with other organs (Fig. 3).

Involvement of the cervical bronchial and mesenteric lymph glands is common occurring most frequently during childhood. The pasteurization of milk during recent years as well as the hygienic inspection of school children has done much toward eliminating this infection. The mes-

through the stomach and lodge on the intestinal mucosa either in the lymph nodules or elsewhere. Here inflammation is followed by ulceration of the mucosa and submucosa. The girdle ulcer follows. The inflammatory process may extend through the muscular coat and a perforation result but the inflammatory thickening of the serous coat usually prevents a rupture. Adhesions to surrounding parts are common. The surgical importance of ulcerative tuberculosis in which extensive ulceration has been present lies in the fact that healing is followed by scar contraction. Intestinal obstruction may result and is treated in the regular manner. The tuberculous condition is unrecognized until symptoms of obstruction present themselves.

During the operative procedure the entire intestinal tract is systematically examined by beginning with the cecum and tracing its course and following the small bowel down from the jejunum. The bowel must be handled with extreme gentleness and care. Shock must be minimized. Rough handling of the bowel may result in an active inflammatory reaction.

enteric glands are infected by the bacilli which pass through the bowel wall (Fig. 4).

Tuberculosis of the uterus most frequently follows a tuberculous infection of the tubes. The disease occurs in the form of nodular or diffuse infiltration which resolves itself into ulceration or necrosis of the mucous membrane and submucosa. The entire organ may be covered by necrotic and caseous deposits.

#### TUBERCULOSIS OF THE FALLOPIAN TUBES

In the female genital tract the fallopian tube is the area most frequently infected by the tubercle bacillus. The fallopian tube is usually the primary seat of the disease and a large majority of cases of general abdominal tuberculosis and tuberculous peritonitis is due to an extension of the infection from this point.

The susceptibility of the fallopian tubes to this form of infection is explained on the ground that the mucosa offers a fertile bed the result of suppurative or circulatory changes occurring in menstruation. This probably accounts for the fact that the infection takes place often between the periods of puberty and the menopause or in other words during the active sexual life.

As a result of improved methods of diagnosis an increasing number of cases of tuberculosis of the oviduct are being reported as primary.

In my series of cases there are 3 in which the oviduct is the only site of tuberculosis. I think much caution should be exercised in pronouncing the condition primary only after the most meticulous examination is such a diagnosis warranted.

The pathologists inform us that the mucosa is the first portion of the tube to be attacked the infection then spreading until all coats are infected. Tubercles are present on the peritoneal surface of the tube in only about 50 per cent of the cases. But the flare of the fimbriated end of the tube glistening and moist is quite characteristic. The tube may be normal in size or greatly enlarged. Caseous material is often seen and in advanced cases the peritoneal surface is coated with a yellowish gray cheesy material. Certain types of tuberculous salpingitis resemble chronically infected tubes and cannot be distinguished from pyogenic infections. Leucorrhœa is present in 75 per cent of the cases.

The macroscopic diagnosis of tuberculous salpingitis is entirely misleading. The tubal tuberculous involvement is most frequently discovered by histological examination. The uncertainty of an accurate macroscopic examination accounts for the divergent opinion regarding its frequency.

Statistics which place the incidence of genital tuberculosis at from 1 to 12 per cent are unreliable because there is no evidence that a routine histological examination has been made. The University of Pennsylvania has found that in their series of cases 7 per cent of all inflamed fallopian tubes are tuberculous.

During 1913 and 1914 215 cases of salpingitis were operated on at St. Mary's Hospital. Of this number 55 per cent were reported as tuberculous. All operative material at our hospital is subjected to histologic examination.

A description of the characteristic symptoms of tuberculous salpingitis is quite impossible. In the earlier stage of the disease recurrent attacks of pain and tenderness with some degree of menstrual disturbance may be present. Elevation of temperature is common. When it is remembered that the abdominal ostium is usually open and the tube patent it is understandable how obscure early symptoms may be. As the disease progresses adhesions may obstruct the lumen of the tube and the tube may become adherent to the bladder with resultant urinary symptoms. Secondary anemia is present in the majority of cases with resultant menstrual differences. These symptoms are likewise characteristic of pulmonary tuberculosis. The symptoms resemble any pelvic inflammatory condition in its varied degrees with the exception that in tuberculous infections the acute symptoms are vaguely marked while the constitutional symptoms are often very pronounced. Sterility is frequent and in my series 90 per cent of the patients were apparently sterile.

The operative mortality in properly selected cases of tuberculosis of the tube is no greater than that of other tubal infections. We must consider however that the condition is usually secondary to tuberculosis elsewhere and this of necessity makes the risk greater and the choice of anasthetic more important.

*Operative treatment.* Excision of the diseased parts is the necessary operative procedure. In my opinion conservative measures rather than radical ones get desired results. In other words if the tubes alone are involved macroscopically a pan-hysterectomy is not indicated but the tubes should in all cases be excised out of the cornu of the uterus. The ovary is rarely attacked by the tuberculous process. A perioophoritis may be present but it is usually an inflammatory extension. If degeneration is not present the ovaries should not be removed. The condition here is similar to that in the male in which the epididymis is infected frequently and the testis

rarely. If the infection is unilateral both tubes should be removed since repeated histological examinations have proved that this is the safer procedure.

The general operative technique of pelvic surgery is followed. If a mixed infection is suspected the abdomen should be drained. Analyzing the operative results of 100 cases at Johns Hopkins Greenberg reports that of 104 cases in which drainage was used, fecal fistula followed in 18, while in 96 in which drainage was not used, no fistula followed. As it is impossible to eradicate the process entirely by excision, continued minute detailed attention to the general health of the patient is necessary.

The question of whether to drain or not is determined solely by the nature of the infection encountered. If the infection is mixed, drainage is indicated; if it is exclusively tuberculous, no drainage is used.

After the patient leaves the surgeon's care, the real fight begins. It is almost needless to say that the personality and economic status of the patient are all important factors. A great many victims of tuberculous infection are saved in spite of themselves. During my connection with public clinics I saw numbers of patients who, after being treated surgically for tuberculous infections of the abdomen, if left to themselves or to casual

medical care, would return to the most unfavorable surroundings and die a little sooner than otherwise. I have seen patients too ignorant and stubborn to go to public sanitariums, compelled by the physician to spend their days exposed to the sun and air, perhaps in some squalid courtyard screened against flies, given the proper diet and kept from premature exertion while incredulous relatives sneered at the fussiness of the doctors, social workers and visiting nurses. But since tuberculosis is a far more dangerous disease from a public health viewpoint than leprosy, the responsibility of the physician in regard to it must never be limited by the personal notions of its victims.

#### SUMMARY

When tuberculosis involves organs of the abdomen and the general condition of the patient is sufficiently good, surgical interference is indicated. It is important first to determine whether the patient has the vital reserves which will make the operation beneficial, and then to perform the operation with due respect for the generally weakened physique. I refer to the careful minimization of shock, the delicate handling of tissues, and the judicious selection of an anæsthetic and its mode of application. The postoperative care, which by no means ends with the primary healing process, is of the utmost importance.

## SYNOVECTOMY OF THE KNEE JOINT

BY CHARLES H. HEYMAN, M.D., F.A.C.S., CLEVELAND, OHIO

**I**N recent years the operative removal of the synovial membrane to relieve various affections of the knee joint is becoming more and more recognized as a valuable procedure. Although the writer's series of cases is not large, cases of the complete operation a sufficient length of time has elapsed to form conclusion as to its value. It is believed that synovectomy in the properly selected case is a procedure of great merit and has been the only method of obtaining relief for those patients operated upon. It is also the writer's belief inasmuch as a practically normal range of motion has been obtained in all excepting 1 case in which the infectious nature of the disease was not quiescent that the indication may be broadened to include that class of cases in which there is painful and limited motion following trauma with recurring synovitis of not clearly understood etiology. It is the purpose of this paper to discuss the indications for synovectomy and the rational of treatment.

By synovectomy we mean the excision of the synovial membrane as the principal seat of the local pathological change. Strictly speaking the term synovectomy means the complete operation, i.e., the removal of all the synovial membrane which of course include that of the quadriceps pouch, the infrapatellar fat pads and the semilunar cartilages. However I do not wish to limit the discussion to the complete operation as there are certain types of cases in which all of this is not necessary or advisable and will therefore include in this paper a discussion of those conditions in which only a partial synovectomy is advisable.

The classification of arthritis adopted here while not satisfactory is I believe the best we have. I shall not attempt to go into the etiology more than is necessary to determine the indications for synovectomy.

Synovectomy is not new. Although it had long been employed in the treatment of tuberculosis there is only an isolated report here and there of its use in the so-called arthritis cases. Goldthwait (1) in 1900 was probably the first in this country to remove the thickened synovial membrane in several knees with a constant excess of fluid pain and grating on movement. Murphy (2) in 1916 reported cases of synovectomy in villous arthritis.

More than a passing interest however was not aroused until in 1912 when Swett (3) read his

paper at the American Orthopedic Association on

Synovectomy in Chronic Infectious Arthritis. Although it is not the rule, micro organisms have frequently been found in the stained synovial membrane removed at operation and obtained in culture from the synovial exudate. The acutely painful swollen and tender joint with local heat and elevation of body temperature leave no doubt as to the infectious nature of the process within the joint, but it is the exception rather than the rule that positive culture are obtained even though the aspirated fluid is cloudy and the sediment show a large number of pus cells. No laboratory methods as suggested by Burbank are quite likely to demonstrate the presence of the offending organisms in a far greater number of cases. Swett reasoned therefore that these organisms are capable of continuing the activity of the process within the joint as well as causing metastases into other and previously uninvolved joints and that there is a much logic in their removal as there is in the elimination of the original portal of entry. In other words the infected synovial membrane is the source of infection and remains so even after all other foci have been removed. He also believes that a prompt restoration of function stimulates local metabolism which Pemberton has found to be fairly constant as a suboxidation process which prolongs the arthritis.

Before we proceed to a discussion of the selection of a diseased joint suitable for synovectomy it will be necessary to review briefly the anatomy and the changes present in arthritis. It is apparent that the better we understand the reactions of synovial membrane to injury and toxin the fewer mistakes we shall make in selecting our cases for synovectomy.

The synovial membrane lines the deep surface of the ligamentous structures of the lateral and anterior parts of the joint. It is reflected over the semilunar cartilages, the infrapatellar fat pads and the crucial ligaments on the anterior and lateral aspects. It does not completely invest the posterior surface of the posterior ligament. In the anterior part of the joint it is prolonged proximally beyond the articular surface of the femur in the form of a pouch under the cover of the quadriceps tendon. The subcrureus muscle is inserted into the wall of this pouch and its function is important as it prevents pinching and injury to



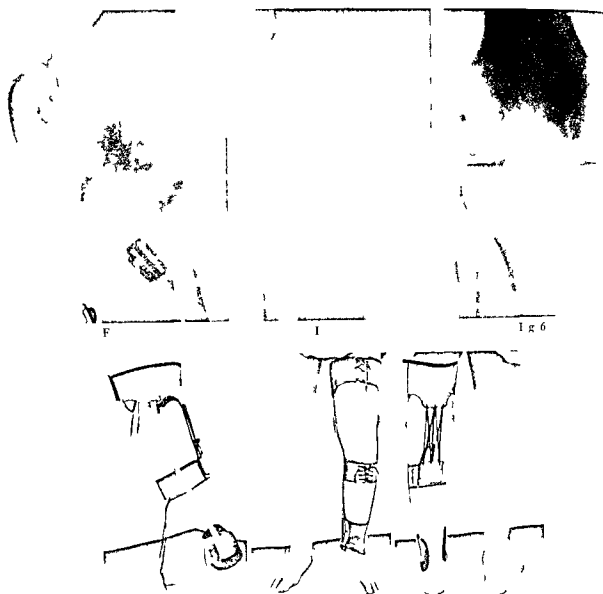


Fig 3 4 a d A t f t r y l t h k t

Fig 6 A t f t r y l t h k t

the synovial membrane on extension of the knee. The synovial membrane also invests the semilunar cartilages and a pouch like diverticulum is prolonged posteriorly and distally along the tendon of the popliteus which it partially encloses thus forming a posterior compartment connected with the anterior chamber by narrow

passages. Fibers of the gastrocnemius are attached to the posterior capsule thus again taking up the slack and preventing the pinching of the synovial membrane when the knee is flexed. The infrapatellar fat pad requires particular mention because of its frequent hypertrophy and consequent internal derangement of the knee

The pad is extrasynovial but intracapsular and is placed under the deep surface of the patellar tendon and fills up the interval between the patella femur and tibia adapting itself to the various forms which this recess adopts in the different movements of the joint. The synovial membrane separates it from the interior of the joint and from its surface a band of this membrane extends to the intercondylar notch where it is attached. This band is termed the ligamentum mucosum and its lateral prolongations inserted into the capsule are the alar ligaments. These are not ligaments in the ordinary sense of the word but are merely folds of synovial membrane. Contraction of the subcrureus muscle transmitted through the capsule and alar ligaments is believed to pull the fat pad up out of danger on extension of the knee. Thus it may be seen that an underdeveloped quadriceps muscle may result repeatedly in injury to the synovial membrane on motion of the joint. We may say in passing that physiotherapy directed toward increasing the muscle tone and the developing of this muscle is important in the treatment of knee joint disease and in postoperative cases. Massage directly over the capsule and synovial membrane is contraindicated as it leads to still further irritation congestion swelling and so forth.

Synovial membrane which has been traumatized becomes congested and swollen and there may be small extravasations of blood with exudation of a thin yellowish fluid containing small flocculi of fibrin. The reactions to injury and infection are very similar and are manifested clinically as synovitis or thickening of the synovial membrane and joint capsule. In more severe cases the exudate becomes more abundantly fibrinous and the synovial membrane is thickened swollen thrown into folds with villous projections and infiltrated with inflammatory products. In the chronic inflammations pannus like growths may extend over the articular surfaces from the periphery and there may be hyaline or fatty degenerative changes or the deposition of cartilage or bone within the synovial membrane. Static defects may cause relaxed lateral ligaments with a less stable joint and therefore increase susceptibility to injuries and toxins.

I shall not attempt to go into the causes of chronic arthritis. When we speak of chronic arthritis it is important to specify which particular type we have reference to as there appear to be at least 3 distinct types each having a different cause. Data on procedures such as the removal of foci of infection are of no value unless the particular type of arthritis under considera-

tion is specified. For example if we were removing foci of infection in those types of arthritis probably caused by trauma or strains our results would naturally not be encouraging and in reporting our failure we would condemn the procedure as having no value in the treatment of chronic arthritis in general while there is no question as to its value in the treatment of the infectious type. Similarly all types of arthritis are not accompanied by marked changes in the synovial membrane and it is irrational to expect favorable results from synovectomy in all such joints. A discussion on synovectomy in chronic arthritis is therefore of no value unless we are able to recognize the type for which we are proposing synovectomy. This is not always easily determined as there are mixed types which can not be accurately classified.

It is unfortunate that there is no commonly accepted classification or nomenclature. There are or have been at least 14 different classifications each having its own adherents. Until there is agreement as to etiology there will continue to be different classifications thus causing the utmost confusion. It is necessary to be familiar with the different classifications if we are to interpret reports intelligently. For example when Fly speaks of Type 1 he has reference to the infectious or atrophic type while Fisher in speaking of Type 1 refers to the hypertrophic type. The importance of a standardized classification is therefore apparent.

In this country probably the most commonly accepted classification is that which recognizes 3 distinct types the infectious the atrophic or rheumatoid and the hypertrophic or osteoarthritic. We shall not enter into a discussion of the etiology of the different types of arthritis. Suffice it to say that the infectious type is clearly caused by the spread or the absorption from some source of infection. There may or may not be an actual invasion of the joint structures.

The evidence is not conclusive that the atrophic and the hypertrophic types are infectious in origin. The rationale of synovectomy is either the removal of the focus of infection within the joint itself or the removal of the sources of mechanical irritation. For the present our indications must therefore be confined to the infectious type or to any type in which large synovial fringes or cartilaginous bodies are aggravating the inflammation by forming obstacles to motion.

#### INDICATIONS FOR SYNOVECTOMY

Careful selection of cases is necessary. The disease must be localized in one or a few joints



damage to the synovium resulting in disability even after the original offending factor has been removed. The anterior aspect of the knee is sensitive, and extension of the knee is painful and limited.

Under this heading may be mentioned hypertrophied infrapatellar fat pads. Through trauma or from the absorption of toxins the fat pads become swollen. On full extension of the knee the enlarged fat pad becomes pinched between the articulating surfaces. As a result of this mechanical irritation it becomes still further swollen and congested and therefore still more likely to be pinched. The patient complains of pain at the infrapatellar region on extension of the knee and there is tenderness on each side of the patellar tendon. Because of the pain an early atrophy of the quadriceps muscle develops and the fat pad is not protected by the action of this muscle from injury. Thus a vicious circle follows. The treatment of this condition is not fixation—as this causes a further atrophy of the quadriceps—but measures to prevent complete extension of the knee by means of suitable apparatus. If after a reasonable length of time recovery does not follow it is conservative treatment to remove the offending fat pad before irreparable damage to the synovial membrane results. This may be done through lateral incisions.

The writer has not found the Jones knee cage brace a satisfactory apparatus to check movement of the knee short of complete extension. Even very tight strapping both above and below the knee does not prevent it from slipping downward so that the hinge is not opposite the axis of motion in the joint. The tight bands also cause swelling about the knee and leg through passive congestion and the pressure of the straps over the quadriceps causes an atrophy of this muscle. Patients also object to a brace extending to the sole. Figures 3, 4, and 5 show a brace which has proved to be very satisfactory in checking complete extension of the knee. It remains in place and is comfortable to the patient. Tight lacing is not necessary.

**Chronic inflammation.** There is a second group of cases in which the bone changes may be slight or absent. The synovial hypertrophy becomes extreme forming pedunculated growths. This is commonly called villous arthritis. The synovial membrane is markedly hypertrophied and is thrown into folds or villi thus giving the surface a velvety appearance. Clinically this type of joint shows more or less swelling with increase in fluid, thickened capsule and a doughy consistency. There is marked grating or joint crepitus.

The villi project themselves between the articular margins and are thus subject to repeated traumatization. This villous hypertrophy is not nearly so prominent a feature in the hypertrophic arthritis as in the atrophic and infectious arthritis. Its effect is to cause mechanical obstacles to free motion which of course must aggravate the existing inflammation. A vicious circle again develops and the benefit of removal is evident. In this type of case excision of the entire synovial membrane is indicated and if the semilunar cartilages are thin or frayed out these also should be excised. It is just a question of degenerative changes from this condition to that of the next group or osteochondromatosis.

Figure 6 is the roentgenogram of a man aged 46 years who for the last 6 years complained of pain and stiffness in the right knee. There was an extreme doughy swelling about the knee and very marked grating on movement. There was only 40 degrees motion between 110 and 150 degrees. There was no acute tenderness. For almost the entire past year he was able to work only at a sitting job. The roentgenogram shows but little bone change. He returned to work at a striding and walking job in an automobile factory 7 weeks after operation with 60 degrees motion and has been working steadily ever since. At present he has 90 degrees motion between 90 and 180 degrees.

**Osteochondromatosis.** In osteochondromatosis there are numerous cartilaginous bodies of various sizes within the joint. They have their origin in the synovial membrane. They may be free or attached by a pedicle or may be completely hidden from view buried within the thickened synovial membrane. It is therefore impossible to remove all of these bodies without removing the synovial membrane. Even if this were possible it is likely that others would form to give trouble later.

**Hypertrophic arthritis.** Loose bodies in the joint may form from fractured nodules generally from the femoral and patellar surfaces. These are commonly called joint mice. Since their origin is not from the synovial membrane synovectomy is not indicated unless secondary synovial changes as a result of the repeated traumatization caused by these joint mice are sufficient to give trouble even after they have been removed.

Synovectomy should not be recommended as a procedure to increase the range of motion when the patient's chief complaint is stiffness and not disability because of pain. However the removal of the source of irritation and infection is expected to result in a greater range of motion. Complete

removal of the synovial membrane is bound to result in a more or less scar formation which may limit motion but if the disease is mainly confined to the synovium without marked destruction of cartilage an increased range of motion may be expected. It is not safe to promise the patient a greater range of motion because of the difficulty in determining quiescence or the degree of cartilage destruction as mentioned before. Sweet however advises the operation in joints in which the process is still active.

Synovial membrane regenerates after synovectomy. The experimental work by Key (3) shows that new synovial membrane is formed by metaplasia of underlying connective tissue. His observations have been confirmed by Wolcott (6) who in addition has demonstrated the regeneration of the infrapatellar fat pad.

#### DESCRIPTION OF THE OPERATION

A longitudinal incision is made over the anterior surface of the knee directly in front of the patella. The incision extends upward and is carried through the quadriceps tendon and downward through the patellar tendon. The patella is split or sawed through vertically just medial to the middle line and the two halves are retracted widely giving a very complete exposure of the joint. It is best to do the operation under a tourniquette as the chronically inflamed tissues bleed freely and hemorrhage is difficult to control. It is also advisable to prevent bleeding as much as possible so as to minimize frequent sponging which may injure the delicate articulating cartilage. Sponging is best done by soft pledget of cotton.

The entire synovial membrane is then carefully dissected away down to the joint capsule and the infrapatellar fat pad removed as well. If the cartilages are damaged these are also removed.

Before closing the wound the tourniquette should be removed and the greatest care taken to control hemorrhage. If blood is left in the joint it organizes and forms adhesions which will pre-

vent free motion and cause pain and may cause a destruction of the articulating cartilage. The wound is carefully closed in layers. It is not necessary to put sutures through the patella. Interrupted chromic sutures through its thick and tough periosteum is sufficient.

For the first 4 days the joint is kept at rest mainly to prevent intra-articular bleeding which forms adhesions. A Thomas splint which has been provided with a hinge at the knee joint is applied with moderate traction. Active motion is initiated upon gradually increasing in range from day to day. It is important that complete extension be at all times possible. If motion is possible to rapidly this may be lost as it is easier to flex the knee than extend it. After weeks crutches are allowed with light weight bearing. Much more rapid progress is made when the patient is up and can force flexion by placing his foot on the floor. I do not believe that passive motion is of much assistance but early massage to the quadriceps muscle hastens recovery because of the atrophy which follows opening the joint. Too vigorous treatment does harm as it leads to irritation muscle spasm and a loss in the gain of motion. Forceful manipulation under a general anesthetic should not be necessary and one should be extremely cautious in its use. Gentle manipulation may be permissible after the end of 4 weeks but the joint should be put through its range of motion only once. Great care must be used to avoid causing any active inflammation as the inflammatory products are likely to result in still more extensive formation of adhesions. A rule crutches may be discarded at the end of the fifth week.

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# AN ANOMALY OF INTESTINAL ROTATION

By J. W. GILLY, GILLY, ILLCS, CARDIFF, WALES

**E**XAMPLES of abnormal position of the abdominal viscera have been reported at various times by surgeons and anatomists but only lately has their importance been adequately appreciated.

A failure of the third stage of rotation of the mid gut loop in which the ascending colon and caecum normally lose their primitive mesentery and by the process of zygosis become fixed to the posterior wall of the right loin and iliac fossa is by no means uncommon and varies in degree from an unduly mobile caecum to a floating caecum and ascending colon which retain their primitive mesentery a subject which has recently been fully treated by Waugh (4).

A case of this kind I recently came across in the course of an exploratory laparotomy on a man of 76 suspected to have a growth of the ascending colon. A caecum and ascending colon with a complete mesentery were readily brought out on the surface and the supposed growth proved to be a mobile kidney. His symptoms of discomfort in this situation were only of 3 months duration and it appeared probable were due to the kidney having recently become mobile owing to loss of fat. An interesting feature was that the mobile caecum and ascending colon had never caused him trouble in the course of a long and active life. The case here reported is one of failure of the second stage of rotation. It is the first of its kind that I have come across or at any rate recognized and as the condition is decidedly rare and also somewhat puzzling when found it appears worth recording in some detail.

Mrs. A. N., aged 57 years, the mother of four children was sent to me with the following history. For many years she had suffered from epigastric pain shortly after meals and a feeling of fullness and flatulence which were relieved by the belching of wind or by the removal of her corsets. During the past 6 weeks her symptoms had become greatly aggravated vomiting had supervened and she was practically unable to keep down any food. It appeared to me to be a case of cholecystitis (a high opinion I subsequently heard from her doctor was also my own) and I advised operation regarding which she was at first most averse. However her symptoms became so distressing that she urged that the operation be performed earlier than had been fixed and I was informed that the night preceding the operation the belching of wind was incessant.

Laparotomy by a right upper paramedian incision disclosed a normal appearing stomach and first stage of the duodenum. The gall bladder contained no stones but as there were some yellow streaks of lipid material in its

wall and a lump of fat at the neck it was removed without any difficulty. A mobile caecum with a complete mesentery was brought up into the wound. The ilium entered it on the left side normally and the appendix showing no evidence of disease was returned into the abdomen. It was then noticed that a large amount of small intestine lay to the right of the caecum and ascending colon and when the cecum was traced up it was found that in the right hypochondrium there was a circle of U-shaped loops plastered on to the posterior abdominal wall. They were kinked moderately dilated and fixed to each other by membranous adhesions. The loop passed below the transverse colon and to form the duodenojejunal flexure in the normal situation. An attempt was then made to unravel the above mentioned adherent coil when it was found that the jejunum occupied the second and third stage of the duodenum and passed directly into the jejunum. This condition shown in the diagram was verified by a limited examination postmortem. The superior mesenteric artery did not cross the duodenum but ran down to the right of the caecum and a cecocolic loop. As it then became apparent that her symptoms were in all probability due to a form of chronic duodenal ileus an attempt was made to relieve this by removing the first free portion of jejunum to which corresponded to the second stage of the duodenum and it appeared that this had been done without causing any kinking. However a gurgling vomiting followed the operation persisting in spite of washing out the stomach so that it became necessary to reopen the abdomen 2 days later. Although the efferent limb was kinked at the site of anastomosis and the drainage of the loop was not efficient they were only moderately dilated and the stomach not at all but there was great distention of the whole of the remainder of the small intestine which appeared to be in a condition of paralytic ileus. A jejunotomy was performed but the patient's symptoms were not relieved and she succumbed on the following day.

The great distention of the distal small intestine suggests that a partial torsion may have occurred as in the condition described by Dott (2) as mal rotation but in the limited examination permitted postmortem this could not be determined and in the course of an operation such complicated conditions are often difficult to determine with accuracy. As regards the original operation of jejuno-oduodenostomy an anterior gastrojejunostomy would have been far preferable and might have been attended with a different result. It is for this reason that in obscure abdominal conditions in which no very definite cause is found when the abdomen is opened their possible presence should be borne in mind and the most appropriate method of dealing with them carefully thought out.

A reference to the diagram shows two U-shaped coils. In the angle between the descending limb of the first and the pyloric portion of the

removal of the synovial membrane is bound to result in a more or less scar formation which may limit motion but if the disease is mainly confined to the synovia without marked destruction of cartilage an increased range of motion may be expected. It is not safe to remove the patient a greater range of motion because of the difficulty in determining quiescence or the degree of cartilage destruction as mentioned before. Swett however advises the operation in joints in which the process is still active.

Synovial membrane regenerates after synovectomy. The experimental work by Key ( ) showed that new synovial membrane is formed by metaplasia of underlying connective tissue. His observations have been confirmed by Wolcott (6) who in addition has demonstrated the regeneration of the infrapatellar fat pad.

DESCRIPTION OF THE OPERATION

A longitudinal incision is made over the anterior surface of the knee directly in front of the patella. The incision extends upward and is carried through the quadriceps tendon and downward through the patellar tendon. The patella is split or sawed through vertically just medial to the middle line and the two halves are retracted widely giving a very complete exposure of the joint. It is best to do the operation under tourniquette as the chronically inflamed tissue bleed freely and hemorrhage is difficult to control. It is also advisable to prevent bleeding as far as possible so as to minimize frequent irrigation. Sponging is best done by soft cotton.

The entire synovial membrane is then dissected away down to the joint capsule. The infrapatellar fat pad removed as the cartilages are damaged these are left.

Before closing the wound the joint should be removed and the greatest control hemorrhage. If blood is left it organizes and forms adhesions.

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## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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JANUARY 1978

#### DIAGNOSIS: THE CRUX OF THE PROBLEM OF ACUTE OSTEOMYELITIS

THE comparison between acute appendicitis and acute osteomyelitis is not a new one. More than one writer has pointed out that the diagnosis of one condition is no more difficult than the diagnosis of the other and that prompt treatment is equally important in both. Unfortunately, however, the comparison ceases at this point. In the great majority of cases today acute appendicitis is promptly diagnosed and promptly treated by the correct surgical measures. But acute osteomyelitis is diagnosed correctly only in a relatively small percentage of cases and it is treated so largely by medical methods that more than one observer—the writer is numbered among them—states without qualification that acute osteomyelitis is practically never seen in its initial stages in the surgical wards of public hospitals.

The general practitioner is blamed unjustly for many things, but the tragedies of acute osteomyelitis only too often lie at his door. He sees the patient first; he makes the diagnosis in a regrettably large number of

cases; he makes it incorrectly and he uses temporizing medical measures (chiefly the administration of salicylates) at the only time when benefit can be expected from any thing short of a mutilating operation. Then, when the damage is done, when the true condition is revealed, the patient is turned over to the surgeon, who is expected to work the miracle of a cure in the face of extensive bone destruction and lessened constitutional resistance. The giving of a cathartic has complicated many a simple appendix and in exactly the same way the medical treatment of osteomyelitis and the resulting loss of time may convert a relatively simple condition into one which jeopardizes both life and limb.

The records of one New Orleans hospital for the last 6 years show that in 75 per cent of the cases the patients who were later proved to have the disease were admitted with no diagnosis at all; in 50 per cent the diagnosis was incorrect and in only 25 per cent was even a tentative diagnosis of osteomyelitis made, in spite of the fact that all of the latter group exhibited fairly advanced stages of the disease. It is obvious that a condition which exhibits a 75 per cent error in diagnosis is not likely to result in a high percentage of cures.

The astonishing part of this situation is that the diagnosis is not difficult to make if only the possibility of the disease be borne in mind. The clinical picture is perfectly clear-cut. Acute osteomyelitis occurs most often in young children and there seems to be a definite seasonal incidence. The summer incidence may be attributed to the prevalence then of minor skin infections; the fact that swimming is a popular amusement and the



likelihood that chills may follow getting out of the water. The winter incidence is easily explained by the prevalence of tonillitis and ordinary cold. It is admitted that the disease most often originates in either local skin infections or in infection of the cavities of the head. Traumatism is not an important consideration except in so far as it acts in the localization of the infection by providing a suitable field for the growth of the bacteria.

The first symptom is persistent localized pain near or in a joint. Then come chills and a temperature of 100 degrees F or higher, the usual manifestations of toxemia and a definite leucocytosis. Such a syndrome is almost pathognomonic and it might be well to add that a negative Widal examination at this stage paradoxically enough confirms the diagnosis by the time gross changes can be demonstrated radiologically the disease is no longer in the early stage.

The localized pain should be enough to eliminate such diagnoses as intestinal upset and typhoid fever. Acute articular rheumatism and acute infectious arthritis offer more reasonable grounds for confusion but even here the differentiation should not be difficult. In the former disease there is a more gradual onset, less constitutional reaction and a definite localization of the pain in the joint rather than merely in its neighborhood. Most important of all, unlike osteomyelitis, it is practically always a multiple affair involving several joints. In arthritis there is more joint fixation from muscle spasm and the swelling of the synovial joint membrane is in marked contrast to the practically negative physical finding of acute osteomyelitis in its first stages.

The disastrous consequence of an incorrect diagnosis are only too well known but they were recently brought home very strikingly to the writer by the fact that on his service at

Charity Hospital four patients were under treatment at the same time who combined disability thanks to the type of treatment they had received initially totalling exactly one hundred years. From an economic standpoint if from no other such a waste should not be tolerated.

The necessity for early treatment is clear if the essential pathology of osteomyelitis be considered. It is primarily a metastatic or blood borne disease originating as has been pointed out in some minor skin infection or some infection of the cavities of the head. The septic infect which is always small is arrested by the smallest capillaries of the body, those of the metaphyses of any of the long bones and a true bone abscess forms. Unyielding bone cannot swell as can the soft tissues of the body, therefore bone inflammation can end in only one way, necrosis from local anoxia. If an avenue of escape is not opened the necrosis becomes more extensive, the resulting toxemia becomes more extreme, a terminal septicemia may result and the patient may lose his life as well as his limb. If he survives radical treatment is necessary, varying all the way from simple removal of the sequestrum to complete excision of the shaft of the bone.

The safety and simplicity of treatment in the initial stages of the disease is in marked contrast to this tragic picture. Limitation of the process can be achieved in practically every early case by simply boring small holes in the cancellous bone structure with an ordinary carpenter's gimlet. Such a procedure done under aseptic precaution can do no possible harm even in the occasional case in which the diagnosis has been made incorrectly, while in the great majority of cases it will mean the preservation not only of function but often of life itself.

URBAN MAES

# THE CHANGING CONCEPT OF THE TREATMENT OF SYPHILIS

FOR decades preceding the recognition of the spirochæta pallida by Schaudin and Hoffman and the synthesis of salvarsan by Ehrlich the treatment of syphilis was simple and uncomplicated. However since 1915 there has been a progressive advance in syphilotherapy. In a surgical practice approximately one syphilitic will be found among 10 or 1 patients therefore the therapeutic trend of syphilis is of significance to the surgeon. Salvarsan now called arsphenamine controls the infectious lesions of syphilis rapidly and is essential in public health work. The more benign manifestations such as cutaneous or osseous gumma likewise melt rapidly following its use but the more vital the organ involved the less complete is the recovery as for example the cardiovascular and central nervous systems. The drug relieves the symptoms and arrests the progress of syphilis when used in conjunction with other metals in from 75 to 80 per cent of cases and it is for the remainder of this group that new methods of treatment are sought.

The various modifications such as neoarsphenamine and sulpharsphenamine and the newer methods of administration have decided advantages in certain cases but have not proved arsphenamine to be a panacea. The original conception that one dose cures was discarded shortly after its advent and we now know that rarely will 100 doses cure when 10 or 50 have failed. In contrast it has been suggested that the intensive use of salvarsan in the early course of the disease predisposes to the development of neurosyphilis but accumulated evidence does not uphold this. As the shortcomings of arsphenamine were recognized newer remedies were sought to prevent the serious sequelæ of the disease.

Mercury by inunction or intramuscularly was revived and was used in conjunction with arsphenamine because it had been shown that mercury by mouth was wholly inadequate to control the disease. At the present time certain syphilographers resort only to the use of mercury by inunction during the early phase of the disease believing that the allergic influences that are stimulated by rubbing materially aid in control of the infection. The use of the iodides has always been advocated in the late form of the disease without knowledge however of what is accomplished or how.

Various other metals have been used in an effort to find a substitute to fulfill the faith originally placed in salvarsan and bismuth seemed most closely to approach the ideal. Its use intramuscularly does not supplant the arsphenamines but it has possibly a higher therapeutic efficiency than mercury. Continued experience with bismuth may reduce the enthusiasm attending its present use.

The intensive application of arsphenamine, mercury and iodides will cure approximately 75 per cent of patients with acute syphilis who follow the therapeutic regimen outlined for them. The time, energy and expense entailed in such a course of treatment is greater than the majority of young adults who are most prone to acquire the disease will expend in ridding themselves of the infection. Hence the frequency of clinical relapse in acute phases of the disease.

The period of latency varying from a few years to twenty years or more is dependent on the patient's resistance to the infection. In contrast the patient in whom paresis or syphilitic aortitis develops within three years after the infection is acquired lacks a defense reaction mechanism. In other words the type of soil on which the spirochæta pallida falls determines the crop of complications to be

reaped. Unfortunately arphenamine influences this soil but slightly.

Wagner von Jauregg suggested the use of malarial fever in the treatment of general paresis because it had been known for many years that a patient with psycho is often improved after a period of fever. It has been shown by investigators in this country and in Europe that the production of fever has caused remission in about 40 per cent of cases of general paresis treated by this method. It should be borne in mind that a disease which produces symptoms by destruction of tissue will not clear up without leaving symptoms or scars and so the results of this new treatment should be graded by the economic good that is accomplished for the patients and not by the disappearance of the objective signs of the disease. To condemn the method because the Argyll Robertson pupils or the sensory changes or the deep reflexes remain unchanged is unfair. If the patient is restored to his former occupation or if more menial work permits him to support his family the method is worthy of further trial. The remission produced in 40 per cent of the patients treated compares favorably with the remissions that have occurred spontaneously for years in 10 per cent of patients with general paresis.

The mechanism by which a series of from twelve to fourteen attacks of malarial chill and fevers produces this remission is not understood. It has been suggested that the temperature itself has had a prominent part in the result or that the plasmodium vivax stimulated an immunity reaction against the spirochæta pallida. Assuming that both of the forces are essential nevertheless some

other influence must be at work and of these no doubt allergy or umstimmung is the outstanding factor.

The abortive cure of acute syphilis is occasionally unsuccessful. The results in the treatment of the secondary and latent forms are influenced by the patient's resistance and his application of the therapeutic measure suggested. The late visceral complications unrecognized early are amenable to treatment in a high percentage of cases and the progress of the involvement of the nervous system may be retarded in proportion to the time at which treatment is started. If paresis exists remission may now be produced in 40 per cent of the cases by treatment with malarial fever. The modern syphilographers having been disappointed by some of the failures of arsenophenamine are redirecting their efforts to the stimulation of the individual defense mechanism rather than the continual flooding of the patient's blood by intravenous medication. In the fervor that attended the introduction of salvarsin followed by the misconception that since one dose would not cure perhaps 40 or 50 or more would the patient's mechanism of defense was forgotten also no doubt the belief that specific strains of the spirochæta pallida existed that exerted special affinity for nervous tissue or skin or viscera helped to swing the pendulum forcibly toward the concept of specific drugs and specific cures. The modern syphilographer is now anticipating the resistance mechanism and a means of stimulating it rather than endeavoring to overwhelm the spirochetæmia by the intravenous injection of massive doses of arsenic and mercury.

PAUL A O'LEARY





DAVID W CHEEVER  
1831-1915

# MASTER SURGEONS OF AMERICA

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DAVID WILLIAMS CHEEVER

I AM glad to have the opportunity of presenting a biographical sketch of one of New England's great surgeons. When I first went to Boston as a young man in surgery I had the pleasure of attending Dr. Cheever's lectures and clinics where I learned lessons of enduring value. Dr. Cheever was a quiet modest man at once a brilliant operator and a precise sound and conscientious surgeon. He made notable contributions to science which surgeons of this generation do well to study. His lectures which have been reprinted are as readable and as much to the point today as when they were first issued in 1894. They present in graphic language a sequence of events in pathological conditions that gave insight not only into the character of disease and its effect on the patient but also its relation to surgical conditions in general. W. J. MAYO

THE Harvard Medical School and the science and art of surgery in New England were widely influenced during the last third of the nineteenth century by David Williams Cheever. He was of Puritan stock descended through a line of ministers, teachers and doctors from Ezekiel Cheever who came from Canterbury, England in 1637 taught school for 70 years in Boston and vicinity and became one of the earliest and the most famous of the masters of the Public Latin School. Four of these ancestors were graduates of Harvard College and two were physicians—his grandfather Abijah Cheever of Boston a surgeon in the Revolutionary War and his father Charles Augustus Cheever who in a small New England town practiced medicine and surgery, attracted students and with them dissected cadavers in his attic, prepared skeletons and wax injections and did novel operations after reading descriptions in the scanty literature of the period and practicing on what material he could obtain.

The son was born in Portsmouth, New Hampshire November 30, 1831. His life was that of the average New England boy. He remembered helping his father in surgical emergencies before the days of anesthesia. He graduated from Harvard College in 1851 still uncertain as to his career since his father opposed medicine and he himself leaned toward a literary calling. In this doubt an opportunity to study and travel on the Continent presented itself and association with American medical students in their hospital visits brought the realization

that only medicine would satisfy him. He returned and plunged into the Harvard Medical School. Let those who insist on prolonged and rigid pre-medical requirements take note that this man would probably have been lost to medicine if early decision had been necessary!

Picture a leading medical school of 1856. Attendance at three courses of lectures was required—each course consisting of five lectures a day for 4 months. The clinical work consisted of walking the wards of the Massachusetts General Hospital once a week in medicine and once in surgery and of attending a day of showy public operation. In the remaining 8 months the student attended extramural lecture or apprenticed him self to a practicing doctor or lorded or worked at other things. The next year the same course of lectures was repeated and the next then a perfunctory examination and a degree. There was no laboratory work except in anatomy and that was not required but the earnest student could dissect the three parts assigned to him and bargain and dicker for more. Four of the eight professors attracted Cheever—Storer in obstetric, Clarke in materia medica, Henry J. Bigelow in surgery, but pre-eminently Oliver Wendell Holmes in anatomy. To the latter—witty, brilliant, scholarly—he gave allegiance and he dissected and dissected and dissected. Holmes noticed him to his later advantage as we shall see.

Four opportunities each year for interne service were available—two in medical and two in surgical house pupils at the Massachusetts General Hospital. Appointment was not by examination but by co-optation of the trustees. Was it likely that a country boy without influence or friends would be chosen? Cheever thought not and his soul rebelled at possible rejection without trial. He apprenticed him self to the physician of the State Almshouse Hospital on an island in Boston Harbor for a year and a panorama of the needy, destitute and criminal sick passed before him affording a mixture of general medicine, obstetrics, a little surgery, the care of children, contagious disease, skin disease and venereal infections. He compounded medicine, improvised apparatus and was given a free hand with privilege of reference to his chief when he wished. It was good preparation for general practice.

So he hung out his modest shingle in Boston waited a week for his first patient and collected four hundred dollars the first year. He kept the pot boiling by writing essays for the *Atlantic Monthly* and the *North American Review*, he accepted the position of physician to the small pox hospital during an epidemic and conducted it with as little as possible publicity among his patients and friends. And Oliver Wendell Holmes remembered the zealous disector of the class of 1858 and when the demon-traitorship of anatomy became vacant he offered it to him. Thus began 33 years of teaching in the Harvard Medical School.

For 8 years he labored hard at the demon-traitorship making all of the lecture dissections for Holmes, revolutionizing the teaching in the dissecting room and

instituting competitive dissections and quizzes over the cadaver to quicken a dead subject. His constant work on the cadaver turned his mind to operative surgery which he diligently practiced but without much chance to apply it on the living as he had no hospital appointment. The Civil War found him with a wife and small children dependent on his daily work. He gave what service he could as acting assistant surgeon in Washington. Army medical inspectors decried to protect the wounded from the attentions of unskilled and over confident surgeons appraised his work and offered him the control of a large hospital which had to be refused.

In 1864 when he was 33 years of age surgical opportunity knocked at his door and found him prepared. He was appointed surgeon to the new Boston City Hospital the youngest member of the staff. On June first the hospital opened its doors and on that day Cheever did the first operation in the theater under the dome. It was an excision of an extensive epithelioma of the lips and cheek. There was no antiseptics or asepsis no clinical thermometer no hypodermic syringe. But the frequent dressings were with chlorinated soda—a pretty good antiseptic. The silk ligature on the facial artery came away on the sixteenth day and the patient recovered.

There followed 50 years of service to the hospital as visiting surgeon and consultant which constituted the most important single factor in establishing its high reputation among similar institutions. Cheever had a high ideal of the obligations of the hospital clinician to the community and to the profession. The surgical staff under his leadership worked like demons to secure a place in the sun. He reported cases conducted voluntary clinics and ward visits for students and doctors and instituted Sunday conferences for all members of the staff. Competitive examination for house officers were introduced a much needed reform in Boston. Medical and surgical reports were issued edited for 5 years by Cheever and a medical associate. He called these the history of his professional life. It was difficult to attract students because the vested interests at a rival and already venerable hospital monopolized the teaching hours. But students are apt to be independent and seek knowledge wherever it may be obtained. The demonstrator became assistant professor of anatomy and gave courses in regional anatomy. The Czar of surgical Boston objected that such courses were the prerogative of the surgical department (though no one had thought of giving them before) and stopped them with no light or courteous hand. Result resignation investigation by the Faculty reinstatement and promotion to the position of adjunct professor of clinical surgery with opportunities to give didactic lectures at the school clinical lectures at the hospital courses in regional anatomy and to have a seat in the Faculty. Thus always may humiliation come to him that cannot brook an honorable young rival!



Those were great days. The chair of clinical surgery was established in 1815 and Cheever was its first incumbent. He established the weekly conference, a clinical report by a student with references to the history and literature of the subject, read before the assembled class and teachers. Henry J. Bigelow gave the didactic lectures in surgery. Cheever gave the clinical instruction. In 1888 on the resignation of Bigelow, Cheever was appointed professor of surgery in Harvard University—the pinnacle of surgical preferment in New England. In 1893, at the age of 62, fearful lest the years might impair his efficiency without his knowledge and mindful of this calamity among some of his senior colleagues, he resigned the professorship to which succeeded J. Collins Warren. As emeritus professor he gave special instruction at the request of the students; he continued at the City Hospital in the rôle of consultant; and in 1903, at the age of 72, he did his last surgical operation.

During these years Cheever was a leader in New England medicine and his reputation was international. He originated some operations and introduced others to this community. He was the first in America to remove foreign bodies from the gullet by oesophagotomy and his monograph on the subject is a classic. Now the operation is nearly discarded since electrical illumination permits removal without incision. He did cesarean section—perhaps the first in New England. He had the first two consecutive successful ovariectomies in Boston before the days of antiseptics. He did plastic displacement of the upper jaw for removal of pharyngeal tumors; he removed the malignant tonsil by external incision; he worked hard to perfect Wood's operation for the radical cure of hernia. He was well known abroad—Ollier of Lyons corresponded with him about subperiosteal excision of long bones; Reginald Harrison of London about impermeable stricture; Holmes of St. George's Hospital about excision for coarctation; Billroth of Vienna about the tonsil; John Wood of London about hernia. He became a foreign member of the Paris Society of Surgery.

It is hard for us to realize the handicaps under which this work was done. *Anæsthesia was imperfect. There was no antiseptics; or asep is no catgut ligature; no roentgen ray; no electrical illumination of cavities. Typhemia, septicæmia, erysipelas, and hospital gangrene stalked like spectres through hospital wards.*

Then came Lister's beneficent gift and the whole aspect of surgery changed. As was said by a disciple, Lucas Championnière: "Surgery has only two periods, first that before Lister and second that since Lister." The new era found Cheever at the height of his powers and receptive as always to progressive ideas. He adopted Listerism—first the carbolic solution and wound irrigation, catgut ligatures, and then the carbolic spray under which the surgeon worked until his head ached and his hands became numb and even his urine bloody from the renal irritation. Then asepsis supplemented antiseptics and the tremendous field of elective surgery, especially of the great body cavities, was added to the older im-

perative work. Thus Cheever in his long life touched three great epochs as a youth he helped his father operate before 1845, in his early prime he struggled with wound infection before the days of Lister and in his maturity he enjoyed the security and certitude of healing conferred by Lister's gift to humanity.

His operative work was based on painstaking preliminary study and diagnosis, well nigh perfect knowledge of anatomy, familiarity with gross pathology and careful review beforehand of every step and anticipation of every complication. Let the event be what it might it found him ready. His manual dexterity was average, he himself did not think he excelled as an operator. He was imperturbable, steady, unruffled, but these qualities were due to iron control of a sensitive and high strung temperament. His policy was of wise preparedness. His foresight and forethought prevented mistakes in procedure, confidence and insured favorable results. His wide experience in general practice gave him breadth of view and depth of judgment.

Thirty three classes of Harvard medical students delighted in his teaching which after all was the field where he was unrivalled. Perhaps the genius of the old Master of the Public Latin School in Boston was dominant again in him. The demonstration of an anatomical dissection or an operation or a clinical problem or the conduct of a ward visit were to him prized opportunities to teach his precious art to others. The didactic lecture—now justly disparaged in its usual form—was in his hands an important and acceptable instrument of teaching. It was carefully prepared beforehand but delivered extemporaneously in short crisp sentences of Anglo-Saxon English wholly without theatrical effect but lucid, comprehensive, logical. Its principles and epigrammatic precepts remained fixed in the student's mind and guided his later practice. A young graduate versed in short hand took down the lectures as delivered and later with none but minor corrections they were published in book form as *Lectures in Surgery*. In medical education he staunchly supported President Charles W. Eliot in raising pre-medical requirements, establishing a graded four year course and developing clinical teaching.

Cheever felt strongly the obligations of the physician to the community. His steady purpose is expressed in a reminiscent sentence from his pen: 'I have tried to advance our profession. He wrote, lectured, published, supported medical societies and actively abetted all measures looking toward the health of the community and the dignity and high standing of the medical profession. He fought quackery and medical imposture in all their forms. He helped dethrone the notorious coroner system in Massachusetts, worked for privileged medical communications and frequently appeared before legislative bodies. He was president of most of the local medical organizations including the Massachusetts Medical Society and was the seventh president of the American Surgical Asso-

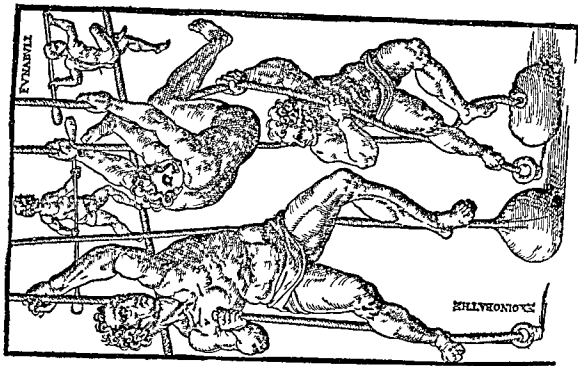
ciation in 1888. For a year he served on the board of overseers of Harvard College. He was a member of the American Academy of Art and Science and an honorary member of the Philadelphia College of Physicians and other societies and a foreign member of the Society of Surgery of Paris.

The personal impression made by Cheever was of a tall slender slightly stooping man with reserved and somewhat grave demeanor but with ready and responsive smile. Intellectual and moral vigor dwelt in a rather delicate physical tenement which he preserved by daily exercise and a mode of life temperate in everything but work. He revelled in the opportunity to dwell with Nature in his vacation and when fatigue and responsibility vanished he was light hearted and witty. With increasing leisure in later years he enjoyed traveling the scenes to which his reading had introduced him. He succeeded in medicine because he loved his profession above all else but his family circle he concentrated upon it during his active years all that he had of talent and energy. He loved especially the human elements of his calling—patients students nurses colleagues and though his manner was reserved and undemonstrative it did not long conceal his warmth of feeling from those about him. His character and personality inspired respect admiration and affection. His qualities and attributes and tastes were thoroughly human but perfectly disciplined to serve useful ends.

In the leisure of advancing years with undimmed intellect but failing physical powers he turned again to intimacy with Nature and to the company of favorite books. In 1915 two months before his death an honorary fellowship in the American College of Surgeons was conferred on him. Of this event Warren wrote: "And when at the recent convocation the honorary degree was conferred upon him and I saw him for the last time in the robe of the order he seemed to me to have come into his own again. The sombre folds of the academic gown served as a fitting setting to the grave and intellectual features of the man and while during a pause in the proceedings arranged to allow him to retire he passed slowly down the aisle leaning upon a proffered arm his assembled colleagues rose as one man to do him honor as a recognized leader in their chosen profession."

DAVID CHEEVER





# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

BY ALFRED BROWN, M.D., F.A.C.S., OMAHA, NEBRASKA

### CONCERNING THE GYMNASTIC ART BY HIERONYMUS MERCURIALIS

FROM earliest times history affords many examples of the use of exercises both in military and civil life. The ancient athletic games of Greece, the gladiatorial and other contests of ancient Rome, and the evidences of contests of athletic prowess among the eastern peoples all bear witness that from the Dawn of Civilization the training of the human body to withstand the physical stress of life had its place. That these exercises were graduated and carried on according to an orderly scheme with this idea in view is not too well recognized. Likewise the baths of ancient Greece and Rome are commonly looked upon as places of sybaritic enjoyment rather than as institutions of medical and surgical balneotherapy. In fact it has been of only recent date that the true value and place of physio- and balneotherapy have been generally recognized in surgical therapeutics.

Hieronymus Mercurialis made one of the first attempts to bring the efficacy of gymnastic procedures as curative measures before his profession in the sixteenth century. Mercurialis was not only a famous surgeon, holding in succession the professorial chairs at Padua and Bologna, but also was one of the most learned men of his century and interested largely in world affairs. At one period of his life he spent 7 years in the home of Cardinal Alessandro Farnese and employed much of this time in the study of the manners and customs of ancient peoples and later adapted the knowledge thus gained to the medical and surgical practices of his period.

In 1569 when 39 years of age he published the first edition of his *De Arte Gymnastica* and in 1573 the second edition appeared. In this year he was called in consultation to Vienna by the Emperor Maximilian II and as a natural consequence the volume is dedicated to him. The title page reads:

The Six Books of Hieronymus Mercurialis Concerning The Gymnastic Art. In Which Are Diligently Explained the Kinds, Places, Manners, Forms and All Ancient Exercises and Also Whatever Pertains To The Motions of the Human Body. Second Edition Enlarged and Embellished with Many Illustrations. A work not only medical but also very useful to all desirous of learning of ancient affairs and especially of the conservation of health (dedicated) to Maximilian II Emperor. In Venice at the house of Giunta 1573.

Following the usual dedication and laudatory

poems of the writer's friends comes a list of authors whose works Mercurialis has consulted. The first book is largely historical and explanatory. He begins with a sketch of the principles of medicine and lays down the dictum that there are two parts of medicine: the one curative, the other conservative. Gymnastics have to do with the latter part and he passes on to a description of the ancient gymnasia and baths, the plans of which are illustrated as well as described. Finally he ends this book with his division of ancient gymnastics into three types: the gymnastics of war, the gymnastics of medicine and the gymnastics of athletics, and it is interesting to note that he praises medical gymnastics as legitimate and condemns those of athletics as faulty or bad (*ilio seu athletica*). In the second book Mercurialis discusses the various types. He first tells what exercise is and how it differs from labor and simple motion. He describes exercises such as dancing and passing a ball from hand to hand and goes on to the more strenuous exercises such as football, wrestling, boxing and the athletic feats with the discus, etc. In the third book he considers the more truly medical principles of exercise—the benefits of walking, proper carriage of the body, the exercise of restraint, singing and laughing, swinging, riding and many other forms—not the least important of which is the discussion of the necessity for exercise for the bedridden or those who for other reasons are unable to work and get normal exercise in this way. In this class he includes those who must of necessity lead a sedentary life, mentioning in particular emperors, kings and princes. He speaks of the benefits of fishing, sailing, swimming and hunting.

The fourth book is in great part polemic and endeavors to confute the arguments of those on the one hand who condemn exercise as unnecessary in the healthy and on the other those who declare that exercise is necessary and beneficial to all, irrespective of their physical condition. These two classes out of the way, he discusses the proper exercises for various types of persons: the well and the sick, the young and the old. And in the fifth and sixth books develops this theme in detail, prescribing the types of exercise indicated for the different conditions commonly encountered.

The work even at the present day is a mine of information both historically for its description of the ancient gymnasia and baths and its sound common sense advice as to the care of the body through properly guided exercise.

## REVIEWS OF NEW BOOKS

**I** BELIEVE it was Murphy who said that the story of appendicitis should be rewritten each ten years. When one studies the mortality statistics of appendicitis of hospital the country over the statement of Murphy can be amply justified as the mortality rate of this disease is entirely too high. Many competent surgeons have a higher mortality rate for appendicitis than for gall bladder or conservative stomach surgery. The reason is not a lack of skill in operative surgery or surgical judgment but the case comes to the surgeon too late—many times with a ruptured appendix with abscess or beginning diffuse peritonitis. The difficult diagnosis in many instances is not by any means simple and clear cut. One has only to remember the cases of early central pneumonia or acute upper respiratory infections in children that give almost typical symptoms of appendicitis and in contrast the gangrenous appendix that gives practically none of the classic symptoms of acute appendicitis. Relatively speaking no acute disease within the abdomen in its early stage is so frequently mistaken.

The answer is the story must be rewritten and it has been rewritten by Royce. This excellent monograph the author brings to the profession in a most lucid manner the complete story of appendicitis both acute and chronic. The author attempts to give little if anything new but relates in an orderly fashion all the work that has been done in the world over. One must be pardoned for enthusiasm in a man shown for his excellent description of the differential diagnosis. Here lies the crux of the situation and he has ordered it in a most instructive and complete manner. The chapter on omphalocele is complete bringing to the reader attention on such conditions as liver infection, plephric, subdiaphragmatic abscess, intestinal obstruction and the like.

Every practitioner of medicine should profit by reading this monograph in fact the general practitioner will receive from it the greatest benefit as he is the man who sees 95 per cent of the early cases of acute appendicitis and must recognize them in order that prompt life saving measures may be adopted. It is pleasing to note his criticism of the practitioner who tends to attribute fear to advanced surgery. How often this practitioner is misled to disaster.

The author incorporates a accurate description of the Ochsner treatment in indications and method. It is common knowledge that there is one might

say an almost universal misunderstanding as to what Ochsner meant when he advocated this method in 1902 and again in 1911. There is no question but that a wide dissemination of the facts alone will save many lives throughout the world.

What is known today of the appendix its diseases and accompanying pathology and complications and of proper treatment is clearly and concisely set forth in this most excellent monograph.

It's A W FFR

IN the little book on the disease of newborn infants Burnett endeavors to set the student the proper task of glean up a knowledge of the subject from the mass of literature that has accumulated. In this the author has been fairly successful. For his part he has left relatively too much space to the less common diseases but all in all the subjects are presented clearly and concisely and in a most readable manner.

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# AMERICAN COLLEGE OF SURGEONS

## THE PARASITIC ORIGIN OF MAN<sup>1</sup>

THE BIONOMICS OF ANIMAL REPRODUCTION IN RELATION TO TUMORS AND CANCERS

By SIR JOHN BLAND SUTTON Bt 1 ACS LONDON

IT is a privilege to deliver this Memorial Oration. I accepted the invitation because I knew Doctor Murphy and appreciated his zeal for surgery and the ability with which he practiced the art. His enthusiasm as a teacher and as an exponent of surgical pathology is well known and universally recognized. I met him for the first time in London in 1895 at a meeting of the British Medical Association. I was secretary to the Surgical Section and won his heart by finding a cadaver on which he could demonstrate to a group of surgeons his method of making an intestinal anastomosis with the aid of his ingenious button. I was delighted with his technical skill; our friendship was sealed with the button and this metallic device served to fix Murphy's memory in the minds of surgeons throughout the world. He was something more than a mere technician. His deep interest in surgical pathology is manifest throughout his famous *Clinics*. Knowing his interest in the surgery of tumors the oration today is concerned with an aspect of the tumor question which I feel sure would have interested him.

The theory of the origin of man from lower animals finds its surest foundation in embryology, and some remarkable observations and discoveries relating to tumors are concerned with this branch of biology.

The greatest discovery man ever made about himself was when von Baer in 1827 discovered with the aid of a microscope the human ovum. When ripe the ovum is a spherical cell just visible as a mere speck to the naked eye. The riddle of animal reproduction remained unsolved until Koelliker recognized the importance of the minute flagellate cells called spermatozoa. These remarkable cells were discovered by Hamm a pupil of Leeuwenhoek in 1677. They resemble protozoa and were called spermatozoa. For many years they were regarded as parasites of semen until Wagner and Koelliker in 1844 proved them to be histological elements of the testis. No one has

witnessed the union of a spermatozoon with a human ovum; it is a matter of inference from observations made on the eggs of starfishes and amphibrans. In such creatures ova and spermatozoa mingle in the water and come into vital collision and the act of fertilization can be seen under conditions permitting accurate observation. Biologists who have studied the process of fertilization notice that when mature ova are brought into the vicinity of sperm the spermatozoa influenced by their presence make energetic efforts to reach them.

### THE AQUATIC ORIGIN OF MAN

There is good evidence that man is derived from aquatic ancestors and the stages he passes through before becoming fit to be born indicate that the fetus in the womb lives as an aquatic parasite within its mother. When an ovum enters the uterus the overgrown uterine decidua on which it rests secretes a fluid for its nourishment. This fluid is aptly named by Tercher in a recent admirable research uterine milk. The ovum can flourish in this medium about 10 days. If the environment be favorable fertilization is effected by an active spermatozoon. The ovum in consequence of its union with the head of the spermatozoon becomes an oosperm or zygote and is quickly invested with delicate membranes. Of these the outer known as the chorion quickly becomes shaggy with protoplasmic bodies called chorionic villi. These villi erode the adjacent decidua and firmly embed the oosperm; they are in due course converted into a placenta—the respiratory organ of the fetus. Fluid accumulates in the amniotic cavity and in due course the embryo disports itself actively as an aquatic creature in its own amniotic pool.<sup>2</sup> In the early



stage its skin is covered by a single layer of cells. Later this becomes double and the superficial layer is known as the epitrichium. About the eighth month of intra uterine life the epitrichium is cast off mixed with grease from the skin glands and the delicate woolly hairs known as lanugo. This soapy stuff is the vernix caseosa so conspicuous on the skin of the newborn child. The epitrichium persists on aquatic creatures such as frogs and salamanders and protects their skin from maceration. When the human fetus is an aquatic creature disports it self in the amniotic hydrosphere the epitrichium and vernix caseosa protect it from maceration. Occasionally the epitrichium persists and the fetus dies in such circumstances when discharged from the uterus it presents a weird appearance and is known as the harlequin fetus.

The human fetus is an aquatic mammal its blood being oxygenated by its mother's blood by means of the placenta. At birth it is expelled from the uterus discards the placenta and becomes a lung breathing creature.

Few things made a deeper impression on my mind than when as a child I realized that the tadpoles which emerged from the frog spawn in the ditch bordering my playground turned into frogs which jumped among the long grass in the paddock. This was my earliest lesson in embryology. When I became absorbed in anatomy and morphology the changes in the branchial bars as the aquatic tadpole transformed into an air breathing amphibian became more interesting especially on learning that in man their chief representatives are the laryngeal chain of ossicles—malleus incus and stapes—in the tympanic cavity. It requires little imagination to realize that the first landmark in the ascent of man was when the frog first found a voice and left the water but true to its origin it has not returned to the water to spawn.

Recently Feathers in an admirable summary concludes that life consists in organic compounds continually reforming themselves and that the sea is the native environment originally of all forms of life. The importance of water is emphasized by the knowledge that the greater part of our bodies (two thirds) is water.

#### CHORIONIC VILLI

An ovum is propelled through the fallopian tube in about 3 days. Normally the site of the ovum is spent in the cavity of the uterus a suitable place for its reception and nourishment. When an ovum is attacked by a spermatozoon it

is changed from a placid into an active cell which burrows into the endometrium like a voracious parasite. The initial effect of this invasion is the immediate arrest of menstruation no one has suggested an explanation of this remarkable effect.

Thirty or forty days after fertilization the oosperm has undergone some remarkable changes. It has increased enormously and become a cyst with a thin delicate transparent wall containing a visible embryo and its outer wall is shaggy with delicate tufts known as chorionic villi. In the early stages the villi are devoid of blood vessels they consist of an axis of delicate connective tissue supporting cells rich in protoplasm. These cells are peculiar in character and with the aid of a microscope are easily recognized by competent histologists. The chorionic villi are the chief cellular elements of the placenta. The cellular caps of the villi possess trophoblastic cells able them to erode maternal tissues and blood vessels. Chorionic villi have become the subject of intense study. A century ago it was discovered that the curious product of conception known as the grape mole (Traubenmole) is due to changes in the chorionic villi. Examples are preserved in most pathological museums. Scientific knowledge percolates slowly and this discovery remained a curiosity until Sanger and Pfeiffer in 1899 independently described a malignant type of uterine tumor peculiar in structure which attacked parturient women. Subsequent investigations by many observers proved that such perversion is associated with the chorionic villi. It is now well known as chorionic cancer and its prime features are exaggeration of the eroding properties of the villi they penetrate the wall of the uterus and may invade the peritoneal cavity. When they erode blood vessels fragments of the villi are deprived by the blood stream to the heart lung bones vertebra and brain giving origin to secondary deposits and sometimes the patient succumbs with astonishing speed. Examples of the spontaneous disappearance of chorionic cancer have been reported. This betrays its alliance with the placenta which is a temporary organ.

The natural history of chorionic villi illustrates in a remarkable way the distinguishing features of the cancer cell for example its power of independent growth erosiveness and vitality which enable it to undergo dissemination and establish itself in parts of the body remote from its origin.

The natural history of the placenta is also a long but facts have been gradually accumulated which increase our astonishment.

The placenta dominates the life of the fetus. The termination of its intra uterine life coincides

with that of the placenta and at the end of 80 days if the child is not expelled the fetal circulation stops the babe dies the placenta dies and is slowly absorbed. It is significant that a ripe placenta never becomes malignant. The villi—the immature elements—are the source of chorionic cancer.

The pathologist's interest does not end here.

#### OVARIAN DERMoids—MISDIRECTED EMBRYOLOGIC ENERGY

When the wonderful effects which follow the vital collision of a spermatozoon with an ovum were unravelled by embryologists the spermatozoon seemed to be the essential factor in initiating developmental changes in the ovum. There are reasons for believing that this privilege is not peculiar to the tailed cell.

Ovarian dermoids are familiar to surgeons today but fifty years ago they were regarded as curious tumors found after death.

With the establishment of ovariectomy they were found to be common tumors but though common they are very remarkable. Nearly all organs normal to a fetus have been found in them except the reproductive gonads: skin with all its special elements: lanugo hair glands and nails brain tissue choroid plexus and spinal cord eyes teeth cartilage and bone trachea with mucous membrane and thyroid gland intestine and liver. The essential element is a skin covered lump which often resembles a mammary gland sometimes with a nipple surrounded with an areola. Sometimes a rudely shaped head and a stunted limb. These ill formed lumps known as embryomata represent an ovum which has developed without the stimulus of a spermatozoon.

While pathologists were puzzled by such occurrences Loeb induced the eggs of starfishes to segment by adding soda water to the sea water of an aquarium—shock fertilization. Later Batallion induced complete embryogenesis in the eggs of grass frogs by gently puncturing them with extremely thin metal or glass stylets dipped in frog's blood. It is now a common experiment in biological laboratories in spring time to produce fatherless frogs. These experiments have an important bearing on the origin of ovarian dermoids and support the opinion that they are due to the activity of ova.

The nature of ovarian dermoids has engrossed my attention for nearly 50 years. These tumors in some instances weigh nearly 50 pounds. Gradually I realized that the mass of grumous stuff which often forms the greater part of the tumor is excrementitious. The embryoma the essential

part of the tumor is skin covered and the skin sheds epidermis lanugo hair sebum etc. hour by hour day by day month by month and year by year until the accumulated rubbish makes the tumor conspicuous.

I have often wondered at the frequent presence of skin hair and teeth in dermoids and pondered on the absence of intestine. How blind have I been.

A peculiarity of the cubical cells lining the gastro intestinal tract is the large amount of colloid material which forms in them under pathological conditions. The biggest tumors which form in women are ovarian dermoids. Many years ago I urged that the membrane lining the honeycomb chambers of these huge cystic masses was mucous membrane. Gradually I became convinced that they are embryomata in which gastro intestinal epithelium is dominant.

In ovarian dermoid skin prevails and the accumulated rubbish—sebum epidermis lanugo and teeth—is detritus from the skin. This rubbish is the equivalent of the vernix caseosa of the uterine fetus.

In ovarian colloid cysts mucous membrane prevails. The accumulated stuff is pseudomucin furnished by the gastro intestinal epithelium of the embryoma.

Between the extreme types there is every gradation of misdirected embryologic energy. These tumors arise in ova which develop independently of spermatozoa. When an embryoma is well organized the character of the dermoid is easily recognized and it is non malignant. They endanger life by their bulk and septic infection to which they are liable.

Although I have spent much time in studying the minute structure of ovarian dermoids I have not detected in them any evidence of testicular tissue or chorionic villi. In 190 Schlagenhauser discovered in a testicular dermoid tissue identical with chorionic villi. His observations have been confirmed by other histologists. In some instances the tissues closely resemble that of the grape mole.

It is noteworthy that examples of malignant testicular dermoids in which chorionic elements were detected have been associated with enlargement of the mammary glands. After ablation of the affected testis the mammary disturbance subsided.

It is worth mention that among the peculiar tumors which occur in the ovaries of adult women known as papillomatous cysts there is a variety in which the microscopic structure is like that of chorionic cancer. This variety is malignant and is disseminated by the blood stream. The second

ary tumors erode bone with facility. In one example under my observation the secondary growths were in the superior mediastinum and bud like processes eroded the manubrium of the sternum and appeared as currant like nodules under the skin.

*Papillomatous cysts of the ovaries* are as a rule bilateral and occur in women between the twenty fifth and fiftieth years of life.

It is difficult to escape from this conclusion *Pregnancy is an epitome of a parasite infection*.

The fetus may be regarded as a tumor growing within its mother the consequence of an infection by a parasite—the spermatozoon. It is a strange eventful history. Copulation is the method of infection by which flagellate protozoa—spermatozoa—introduced into the female attack ripe ova in the uterine or the tubal passage and convert one or more into oosperms (zygotes). The oosperm embeds itself vigorously in the ripe decidua. The first effects of the infection are a local reaction—the arrest of menstruation and a constitutional response expressed by mammary activity and the secretion of milk and usually pigmentation of the skin localized to certain definite situations. The uterus in a marvellous manner adjusts itself to the growth of the fetal tumor and at the end of 80 days the death of the placenta coincides with labor and the expulsion of the child and its membranes. The fetus becomes an air breathing mammal leads an independent life becomes in due course mature and seeks opportunities for reproducing its kind.

#### PARTURITION

Childbirth is a natural operation and like a surgical operation has its risks and sequences. Of these the two most important are sepsis and cancer—one is immediate and the other deferred.

In spite of the brilliant results which ensued on the conquest of sepsis and the treatment of

wounds childbirth fever persists. It is true that endemic puerperal fever disappeared when Listerian principles were applied but the sporadic form persists and will persist until parturition is conducted on the same strict methods as surgical operations. Take for example cesarean section. In 1860 this ancient operation had an enormous mortality. Today it is safer than normal delivery at term since surgeons have adopted aseptic methods—boiling instruments and ligature material—and especially wearing sterilized rubber gloves when conducting labor.

To reduce the risks of parturition to the level of a surgical operation parturient women should be treated on the same lines as a perspective surgical patient. *She should not be ashamed to wash the gate of birth with the same diligence and care as she washes her face.* Such a toilet is of the utmost value as a protection against postpartum sepsis. Chronic ulcerating septic fissures in the wall of the birth canal are the lurking places of pathogenic germs and potential sources of uterine infection and cancer.

Science hath given a new commandment to doctors and midwives

Th halt a triz rubb glov tik al bot  
f l v n n th l h m g ltl sth t t k th al bo  
f th ta h nd ith l n m d l p h l f b d

We flounder in speculation concerning the causes of tumors and cancers as much as our predecessors floundered in ignorance of the factors concerned in animal reproduction. The microscope enabled us to recognize mammalian ova and spermatozoa and work out their intimate relations.

V ly th t l of a m l p o d t o th m t nd  
ful h st y th l d it a p t m f Ma d nt  
fr m p o t

## THE RESPONSIBILITIES OF THE SURGEON TO THE PUBLIC

BY GILBERT DAVID STEWART, M.D., F.A.C.S., New York

THIS discovery by Pasteur of the causes of many diseases and of most of the plagues that have afflicted mankind changed abruptly and forever the responsibilities of the medical profession to the patient individually and to the patient in mass—the public.

Under the changed conditions the profession in America has striven indefatigably and altruistically to fulfill their responsibilities but the opinion will be here expressed that much of this effort is wasted partly on account of the great number of agencies engaged in giving medical education to the public and the overlapping of their activities but also and chiefly because a large portion of the public cannot understand much of the information offered to them in this way and never will be able to understand it. Further it is believed that the best way of teaching the public is to bring an educated and sincere profession into contact with a sanely intelligent citizenry.

There are in America between 30 and 40 societies national in scope engaged in presenting to the public a certain amount of information regarding a single disease in which they are individually interested.

In addition every large city and most of the small ones have beside their hospitals municipal and private their dispensaries and public health departments many other medical or allied activities covering geographically the block the parish or the town. Some of these function independently many of them overlap to greater or lesser extent while some are in mortal conflict thus it is not physically possible for prenatal clinics and birth control to flourish in the same soil. New York has besides its hospitals and dispensaries more than 30 local or city organizations and Chicago is blessed at least possessed with 15 many perhaps more.

Recognizing that from the multiplicity of these organizations and the variety of their interests there were certain to result overlapping and confusion the Council on Health and Public Instruction of the American Medical Association was selected by the societies to act as the single spokesman for the group that the speaking might be with authority and not a confusion of tongues.

The machinery set up by this council established a press bureau which sent clippings and

other information on medical matters suitable for printing with the imprimatur of the council to 5000 newspapers (this was about 1913). There was also established a lecture bureau and medical lectures were furnished free on request of local societies. A library of lantern slides and other illustrations radio talks and various other services and equipment could be had on demand.

The work done by the profession through the Council later changed into the Bureau has been enormous and of value no doubt but it has not met with complete success. At least it has not succeeded in becoming the universal spokesman for one of the societies referred to has recently obtained a million dollars in order to spread information in its own way about the disease in which it is interested and another is spending several millions a year in similar propaganda. There can be no criticism of the motives which inspire these efforts but surely it is a poor method of instruction that attempts to make specialists of the laity and an expensive method that can teach only one disease at a time.

The International Health Board reports 341 county health units in operation in 34 states for the year 1916. These county units carried to the poor and to those remote from large centers the advantages of up to date methods in medicine. The profession here bore a relation to the public similar to that of the family doctor. Of organizations like these that teach medicine to the public but only as incidental to the treatment of the public there can be no criticism. Lord Salisbury said a missionary must soon be followed by a gunboat but he never meant this to apply to medical missionaries.

## THE EDUCATION OF THE LAITY

The public may be divided into four groups far as their lay education is concerned. A large group receives only the so called elementary education which is compulsory ends at 14 years of age and is now supplemented in many localities by part time continuing schools which carry the student approximately to his seventeenth year. A second group smaller in number receives the secondary education covered by the high school. To a third group less in number than the preceding but still very large for America has more colleges and more college graduates than any other country in the world is given the so called

higher education America has too a relatively large number of illiterates making a fourth group

Reading is not education and the largest group the first will depend largely on the public press for its knowledge of things medical excepting of course those individuals who have a trusted family doctor. Many reputable newspapers and magazines exclude from their columns all medical information of doubtful authority and all advertisements except those strictly ethical. Further many publications have reputable doctors attached to their editorial forces. In spite of this much that is sensational and misleading finds its way into print.

The charlatan and quack have ready access to this sort of publicity and conscious of the fact that the public cannot discriminate are perfectly willing to enter into controversies which serve to advertise their wares while it utterly fails to classify them.

This in passing is an argument against the doctor's advertising himself recently recommended by a well known writer in a reputable publication. The pretender in medicine or a sincere adherent of one of the cults has the same opportunity of advertising there is no tribunal to decide between him and the reputable profession except public opinion and public opinion is not technically well enough informed to make such a decision. The party willing to make the most extravagant claims promising the most to suffering often bewildered humanity has in such a contest an even chance of winning.

Another grouping of society not based on the lay education of the public but on the amount and kind of medical information it wants may be made. Old age is a condition youth seldom feels called on to contemplate. Similarly health arrogant and young or perhaps careless and old is rarely interested in discussions concerning disease. So long as the machine goes on without friction there is no or only a mild interest in the machine but let the evil days fall the man of intelligence seeks the aid of the best doctor he has heard of through his friends the other and he may even be one who has received the higher education flees to the mountains of promise with no rock of achievement beneath.

Beside those who are incapable of receiving and those who do not want medical information there is another large section of the community which wishes to be fooled. Mankind has always been looking for some means of cheating the jinx. For the medicine can possess potency only if its methods are mystical and its terminology turbid. Teach that attenuation increases power

it will be accepted eagerly as long as the reasons are not given or if given are not reasonable. Their credulity may be drawn upon without ever stopping at the boundaries of knowledge and there is no limit to the vasts of ignorance.

In that stage of man's spiritual development when he regarded each object as possessed by an *animus* usually hostile it became necessary to convert it to friendliness. Soon there arose among the sons of men bright shining spirits who for a consideration would undertake these conversions. That these shining ones were the brightest of their tribe and that to them fell these tasks with their remuneration is not to be wondered at or made the subject of crabbed cavilling. This was a state perhaps as necessary in man's progress as was the polytheism of later and admittedly more civilized times. There are still many who prefer their medicine at the hands of the Shaman who expect tumors to be removed by salves that have a *sumping* action, stones in the gall or urinary bladder to be dissolved by waters from Arbanus and Phrypar and from monkeys not merely rejuvenation but resurrection.

To those best educated as education is commonly qualified the doctrines and tenets of the cults often make appeal when couched in terms unintelligible to most. Who knows that a consciousness of calm may not come to comfort the harassed soul and the suffering body through channels unrecognizable by what we commonly call intellect? In understanding doctor meets such cases with sympathy not intolerance. The Romans believed in bodily health as a form of religion holding that spiritual good might enter through the subtle gateways of the body. Every doctor knows that bodily functions are profoundly influenced through the far more delicately subtle currents of the mind.

Among educators today there is a growing conviction that education should never end but should go on all through life. This is an acknowledgment of the fact that there are certain subjects concerned closely with the texture and art of living that cannot be understood until experience with life has touched them and made their import and meaning clear. Aristotle believed that political science was not suitable for and could not be taught to the young. Newman said: Read Horace if you will but don't expect to understand him until after you are 40 years of age.

In Denmark this continuing education is met by the special high schools which are open to everyone over 18 years of age. These originally established to keep alive the language and traditions of the race threatened by foreign aggression

and domination have been continued for the betterment of the people and because of the profound influence they have exercised on the moral, spiritual and even economical welfare of the Danish race. An agricultural people largely it might be supposed that the curricula of their schools would be in some measure at least concerned with farming. Such is not the case. In stead literature, history and art are taught. By means of the first they can count the heart throbs of the world, through the second they learn what institutions man has founded to help him in his upward climb. From these studies held at convenient seasons they go back not away from their farms conscious of the dignity of labor and contented with their lot.

It is this kind of broadening education rather than technical knowledge of medicine that is needed in America today.

The medical profession long ago recognized the need for a continuing education, a necessity sensed by almost no other profession in similar degree certainly by none. Academies of medicine, medical societies, clinical societies and assemblies everywhere bear witness to the desire of the medical profession to continue to learn all through life. Perhaps medicine is more dynamic than the other professions but if this implies a fault it contains a virtue for so is life dynamic and there can be neither life nor world without tradition or without change.

#### STANDING

In no profession are the standards of education so high as in medicine and this is due to efforts of the universities and the state medical licensing boards but mostly to the doctors themselves as represented by the American Medical Association. At the present time 95 per cent have a good general as well as a good professional training and according to the Commission on Medical Education in its preliminary report of January 1917 for the first time the standards of medical education in America bear favorable comparison with those of other countries.

A high standard of education however does not connote a high standard of character or of ideals. The age is commercial and the public is demanding that its higher education be practical in character. A recent writer insists that the male students in the colleges not only do not ask for any cultural or liberal training but that they do not even know the meaning of these terms. Medical education particularly premedical is of course dependent on general education and takes from it both color and tone.

If this is true and if the profession wants the confidence of the public it must be understood that it cannot be had on a commercial basis but only on that of the soundest and highest ideals.

The French have long recognized in their system of education that the cardinal virtues of honesty and integrity are taught by example and not by precept. It is obvious that to have advised the artful dodger that honesty is the best policy would not have succeeded but the example of an honest father or mother would have silently and surely accomplished that end.

While medical colleges then have scanned the antecedents as closely as they have the intellectual equipment of candidates for admission they have made no effort to teach in the school any of the cultural or humane or liberal subjects. It is of course impossible to lecture ethics into students and any age particularly is this true of medical students.

Still there could be no harm in injecting into the curricula overcrowded as it is a short course e.g. on the history of medicine on great epochs and particularly on great men. Pasteur advised young men to reverence their masters and himself gave an example by strewing flowers on the grave of one of his beloved teachers every year on the anniversary of that teacher's death.

To learn with what difficulty new ideas are born and with what tenacity worn-out discarded useless views cling to life is in itself an education in science and humility. At the present moment the colleges have before them the task of clearing out of the attic of the curriculum junk that has been collecting for years. Further because of the rapidity of discovery it will be necessary to recognize that one small herd can never carry all there is to know and to make selections of the material most in demand and most useful. It was Herbert Spencer who pointed out that it might be useful once in a life time while arranging a railway journey to know the names of the cities of England their distances apart and by what railways they might be reached but that compared to other information this was of little relative value and might be looked up with ease on the few occasions required.

The general reaction to the efforts of the medical profession to educate the public and to improve and elevate the standards of the profession is very interesting and tells an eloquent story of increasing (legal) state recognition of irregular practitioners, of wider acceptance of many forms of medical service based on false interpretations of disease, of false theories of diagnoses and treatment of low educational standards and of the

absence of ideals. Under these conditions irregular practitioners according to the report of the Commission on Medical Education have increased 200 per cent in the last 15 years.

There is no question of course that certain broad facts may be taught indeed must be taught to the public e.g. that a lump in the breast of a woman should be investigated that an ulcer anywhere should not be suffered to long continue but there is no formidable array of such facts and the contention is that giving the public information through lectures and newspaper articles often leads them to believe that they themselves are versed in medicine or sends them to worship at the shrine of strange gods.

Let it be again emphasized that a society which teaches the public while treating them assumes the position and relationship of the family doctor.

On the other hand few of the clientele of the altruistic general practitioner ever desert him for

newer gods. Aware of his keen and sympathetic interest of the fact that he knows their systems both physical and moral they care little how much they understand of medicine but greatly how well they are understood.

It is perhaps true that the general practitioner is disappearing. But 90 per cent of the demand on the practitioner (again quoting the report of the Commission on Medical Education) are for illnesses that cannot be treated on a community basis that is for problems of the individual. The general practitioner will reappear. He has been coming and going through the centuries.

When man is suffering perhaps fronting the great darkness there is in his heart a cry for understanding sympathy. Science changes but the emotions of the human heart are constant and men and women still weep over the tragedies of Lurpides but bear with fortitude the prediction of science that they will be superseded by a race of supermen.

## AGENTS MODIFYING THE GERM PLASM

BY CLAUDE COOK LITTLE AND EDWARD ANN ARBOR

FOR centuries the attitude of the medical profession toward heredity has been a matter of great interest and of many hued changes.

As a general thing the physician or surgeon has been brought forcibly and repeatedly in contact with the striking phenomena of such processes as infection, contagion, immunity, and malnutrition. He has therefore been led to express a keen and constructive interest in these things and has aided notably in advancing human knowledge of the fundamental principles which they involve.

During the same period there was until 1900 no adequate laboratory method of testing the strength or nature of the process of inheritance in any given case.

In 1900 however Mendel's Law was rediscovered. At once there was a great increase in the amount and value of genetic research. In the 27 years that have elapsed since then experimental genetics has advanced to a point where our knowledge of the physical basis of heredity is as if anything more extensive than are our facts on many of the processes with which medical men have long been familiar and to which I have just referred.

So rapid has been this progress that many experimental geneticists bewildered by wealth of material and the great number of recorded results have been forced to specialize to some extent. This has resulted in the development of more or less isolated groups all recognizing the same fundamental principles but so far along the road of fascination for their own material that they have lost a sense of proportion in interpreting their results.

An excellent example of what I mean is to be found in Slys work on the genetics of cancer. Having for almost 15 years been in a pathological and out of a genetic laboratory she has collected with great patience an enormous number of pedigrees of families of mice in which neoplasms may or may not occur for the genetic interpretation of which her published works show repeatedly and consistently that she is unfitted. Her interpretations have however been swallowed whole by editors of medical journals and others of the profession whose direct contact with genetic laboratories may in some cases be even more antiquated than is her own. As a result there is bound at some time to be disillusionment, disappointment

and in all probability discredit of genetic methods entirely undeserved by those methods which are in no way to blame.

It seems to me that geneticists are largely at fault for the general situation that has arisen and that they should make every effort to discuss with medical men all matters of general and mutual interest as early and as frequently as may be possible.

It is chiefly for this reason that I venture today to bring up the question of the germ plasm and the responsibility of the medical profession in using agents which may be able to modify the hereditary process in man.

In order to present the matter briefly I shall try to proceed from certain broad generalizations to more definite and concrete applications of genetic research to the problem of radiotherapy.

## LABORATORY STUDIES IN GENETICS AND A SAFE APPROACH TO HUMAN HEREDITY

1. *The nature of present records.* Two methods of collecting records on the process of heredity in man are at present employed. The commoner of the two may be described as *indirect*. In this case the investigator consults with members of a given family concerning the characteristics both physical and mental of other members of that family and records their opinions. It can easily be seen that this procedure introduces grave errors. The opinion of different individuals concerning any one member of the family will vary as will also the opinion given by one individual concerning various members of the family. This method however has given rise to most of the pedigrees and family histories which are published by students of human heredity. Not only is it used by the individual investigators but it forms a large part of the recorded cases on file at such centers of scientific research as the Eugenics Record Office of the Carnegie Institute of Washington.

The second method which may be described as *direct* depends upon records of hospital cases and clinical observations. These records are usually imperfect in that they fail to ascertain by thorough examination the conditions found in living relatives of the individuals under observation. Much amplification is then necessary if records of this type are to have any value. Since the average space between human generations will be in the neighborhood of 25 or 30 years it is quite evident



that records would have to be kept in a consistent manner for a far longer period than has up to the present time elapsed since the establishment of adequate systems of individual record. A marked exception to the usual type of inadequate records is found in the case of the Institute for Biological Research at Johns Hopkins University. There every effort is being made to bring under direct observation all living relatives of any individual who serves as the starting point of an investigation. Since as above stated between 20 and 30 years must elapse before the complete life history of individuals of two generations can be obtained by this method we know that for purposes of present study even the best human records can not provide us with adequate information for a number of years.

*b Records obtainable from laboratory animal.* In many ways the record which can be obtained from experiments conducted in the laboratory are far superior to those referred to above. The accuracy of the records themselves are far greater since the individual animal is under direct observation throughout its life history. The speed of successive generations even in slow breeding animals like dogs is greatly increased in comparison to human beings. In the case of such forms as mice an average of between four and five generations a year means that results will be obtained about 10 times as fast as is the case with humans. Another factor of superiority possessed by laboratory forms is the great number of young which can be produced by a single pair of parents. This fact enables us to determine the extent of variation much more accurately than is possible in the extremely small families of human beings. A fourth factor of great importance is to be found in the controlled environment in which the animal is kept. By making the environmental factor essentially the same for all animal in a given experiment many of the sources of non-genetic variation occurring in humans are eliminated.

*c Comparable nature of germ plasma in man and other animals.* Detailed consideration of this fact will not be necessary since the essential similarity between the sex cells of man and other mammals and indeed between man and all other animal is recognized as a fundamental biological principle. It may be well however to point out very briefly certain of the facts.

Man in common with all other bisexual forms of animal life possesses a definite form which characterizes the gonads of each sex. The morphological differences are carried even farther than in the form of the gonads and are reflected in the actual shape of the male and female sex

cells themselves. The generic resemblance between the human ova and ova of other animals or between the human sperm and the male sex cells of other lower forms is obvious and essentially universal. Similarity of structure within the sex cell itself is also striking. The general relation between nucleus and cytoplasm in the sex cell of all animals is as nearly constant a phenomenon as it is possible to find in experimental biology.

Physiologically also the comparison is a very close one. Thus in the process of maturation, ovulation and the various phenomena of the estrus cycle as well as in the process of fertilization itself man and other mammals follow distinctly similar lines of physiological behavior. The facts clearly indicate that it is possible to draw a close analogy and in many cases a clear homology between man and lower forms.

#### EXPERIMENTAL EVIDENCE

*a The direct effect of radioactive substances on sex cells.* One of the first and most striking series of experiments in this field was carried on by Oscar Hertwig and his children. Using as their material the sperm and eggs of frogs, toads and other animals in which fertilization can be easily observed outside of the body, these investigators tested the effects of mesothorium and various radioactive salts on the process of fertilization and early embryological growth. They showed clearly that the sex cells were damaged by the treatment employed. A light dose of exposure to the radioactive agent allowed the sex cell so exposed to function but produced as a result abnormal and monstrous embryos. A heavy dose given to the male sex cell allowed that cell to retain its motility and to initiate the process of fertilization without taking any part thereafter in determining the character of the offspring. The fact that such exposure produced definite degrees of injury and that injured germ cells could function is important and will be referred to again.

The experience of early workers with X rays and radium showed that complete sterilization was frequently observed where the radio-active substance was allowed direct access to the gonad. This effect has been observed repeatedly in the case of rats by Hooker and in mice by Bagg and the writer. Where sterilization is complete we may with fair certainty conclude that the sex cells have been killed or completely inactivated.

Of a somewhat similar nature but of more importance to medical practitioners is the fact that by a lighter dose of the same radio-active agent temporary sterilization followed by resumption of reproductive activity may be produced. The

experiences of a number of investigators agree in this matter without, I believe any contradictory evidence. This of course would mean that for a time sex cells were killed or completely inactivated but that at the end of that period active sex cells were again formed.

Perhaps the discovery of most importance to the race is that abnormality of structure within the sex cell itself can be produced by exposure to X rays. The experiments of Mavor, Anderson, Muller and others have shown that the mechanism by which regular distribution of the chromatin material within the sex cells is normally brought about is frequently and fundamentally upset following exposure to X rays. Inasmuch as fundamental morphological and physiological abnormalities involving modification of sex sterility and in some cases early death of the individuals are produced by such unusual distribution of chromatin it is easy to see that a very important principle is involved. Not only do such changes in distribution of the chromosomes take place but the appearance of many morphological and physiological variations listed by the geneticist as mutations is produced. Leaving entirely out of consideration the imperfect evidence obtained from reported abnormalities in humans the work which Brigg and the writer have published dealing with mice is strongly suggestive of the occurrence of this phenomenon. The principle is further established by the recent work of Muller who because of the definite information which he possessed concerning his material (*Drosophila*) is in a position to procure incontrovertible evidence. Taken together the cases listed I believe seem beyond any doubt to establish the direct effects of radio active substances on sex cells.

#### DISCUSSION

From the above facts certain lines of reasoning may be followed with considerable benefit. First among these is the realization that any agent producing sterilization by killing or inactivating germ cells holds the potentiality for harm. In such cases it is clear that the effects of radio active substances upon the germ cell may be great enough to cause death, inactivity, malformation or internal upset of the sex cell. *There is no possible way of being sure that any treatments of the gonad with radio-active substance which cause death or inactivity are not also producing in other sex cells of the same individual malformation or internal upset.* This fact is of primary importance and cannot be safely ignored.

The three grades which lead to death, inactivity or malformation of the sex cells are striking

and immediate in their effect. They would force themselves upon the medical profession eventually whether that profession desired to recognize them or not. The upset of the internal organization of the sex cell leading to genetic change is however much more subtle its effects may not make themselves felt for two or more generations as was the case in the mice and in *Drosophila*. Because of the fact that the life of the individual medical man does not commonly span the entire life history of two complete generations the responsibility which he feels for remote descendants of those treated by him has not been as weighty as that felt for the patient himself or his immediate progeny. Only recently have the results of experimentation in the laboratory made it clear that in the case of treatment of the gonads of young people or those of reproductive age it is imperative that the medical practitioner should look beyond immediate results and shape his course of action in such a way as not only to benefit his particular patient but to insure the consideration of the remote descendants of that individual as well.

Certain criticism of this conservative point of view will undoubtedly be made. The use of radio therapy is increasing and its rewards are lucrative. Whole journals are partisan enough to concentrate on that particular field and results which are contrary to the popular desire—that such agents be considered mild and safe—are therefore not apt to be enthusiastically received. One of the most thoughtless and sinister suggestions is found in a recent paper by Dr. M. K. Robinson in which the author cites Nurnberger and apparently agrees with him in the fact that if hereditary defects are produced which are Mendelian recessives the situation is harmless. He makes this assertion because inbreeding in humans is unimportant and relatively rare. Thus he considers that the chance of mating between two individuals who carry a recessive hereditary defect produced by irradiation is not worthy of consideration. What he really is advocating by this suggestion is that we should not worry until such individuals have thoroughly seeded the human race with a wide spread sprinkling of the defects in question. After such seeding however it would crop out sporadically in any locality in a manner entirely beyond our control. This would follow because every individual who carried such a trait would hand it on to approximately one half of his progeny even though it might not appear on the surface. An other criticism advanced by Robinson shows a lack of appreciation of physiological change during the life of a mammal which proves his almost

complete unfitness to approach the matter from an experimental angle. It is of a type of comment altogether too common to those of the medical profession who have forgotten the foundations of scientific criticism and consists of his expectation that repetition of a given exposure of X ray to animals genetically different from those used in the first experiment would produce similar results to those first obtained. There is sufficient genetic variation between brothers and sisters in a single strain of mammals which have not been made genetically homogeneous by continued inbreeding so that one might fairly expect different results to follow an identical exposure to any radioactive agent. This factor of uncertainty is multiplied many times in the case of the human material which in its very essence is highly variable. *The very fact that results of exposures to radioactive substances do not always produce the same results is one of the reasons why in employing them medical practitioners should proceed with the utmost caution.* The use of rays on living material is not nearly so simple as is the use of other agents commonly employed in different type of therapy.

One other point worthy of emphasis and likely to cause confusion and one which is rarely recognized is the fact that the average medical practitioner has not grasped clearly the distinction between transmission and heredity. From a biological point of view the term hereditary syphilis is a misnomer. In this case there is involved definite transmission of an active principle in a relatively unaltered form from one generation to another. *Heredity* on the other hand means that in some way the composition or the organization of the sex cell itself has been altered in such a manner as to produce a reflection of that change in an altered structure or function of the animals arising

from that cell itself. It will be seen that constitutional tendency to susceptibility or resistance to various types of disease and the cause underlying constitutional abnormalities may be produced by a complex process of hereditary although quite obviously their direct transmission would not be likely.

#### CONCLUSIONS

1. The germ plasma is modifiable by certain agents which affect it directly.

Radioactive substances are among the most powerful of such agents.

Any agent which kills germ cells bears the possible power of producing inactivation, malformation and genetic changes when used in decreasing amounts or strength of exposure.

4. The duty of medical men to future generations demands that

a. accurate systems of human record be established.

b. that medical men keep up to date with advance in experimental genetics.

c. that they use extreme caution in advocating the use of agents which may affect the germ plasma in young individuals or in individuals of reproductive age.

d. that they discourage acceptance of results based on control data insufficient in number and inadequate. (In this respect the paper of Robinson before referred to in which the total experimental data consists of eight experiments consisting of one rabbit is an outstanding example to be avoided.)

e. that they encourage the inclusion wherever possible of courses on experimental methods and scientific criticism in the premedical or medical curricula.

# PROGRESS AND PROSPECT IN TREATMENT OF CANCER<sup>1</sup>

By ROBERT B. CROSSLAND, M.D., F.A.C.S., Boston

Chairman, Committee on Treatment of Cancer, American College of Surgeons

THE Committee on the Treatment of Malignant Diseases with Radium and X-ray, of which I have the honor to be chairman, has attempted to make available for study a portion of that great mass of surgical material in this country which may aid in providing an answer to some of the disputed points in regard to the treatment of cancer in its more common situations.

Any attempt to review the literature at once makes evident the fact that published reports of end results in cancer cases from different clinics have been prepared under such different conditions that no combination of the figures presented is possible and the advantage of large numbers of cases in eliminating individual errors and exceptions is thereby lost. To overcome this difficulty the committee has attempted to do two things: (1) to establish a uniform method of classifying and recording cancer cases of the more important regions of the body, and (2) to establish criteria which could be accepted in every clinic in regard to the inclusion or omission of case records for consideration.

Such an effort has placed a great burden upon the individual representatives of the clinics participating in these investigations since all the hospital material for a specified period has to be reviewed and data secured and entered on the abstract cards in accordance with the committee's specifications.

To permit a minimum 5 year end result report the cases to be studied have been restricted to those of the calendar years 1918, 1919, and 1920. In the first investigation that of cancer of the cervix the period was from 1914 to 1919. In dealing with cases treated so long ago it was necessary furthermore to restrict the investigation to those clinics in which accurate records, adequate pathological service, and a complete follow-up system were at that time in operation.

One preliminary report on the end results of treatment of cancer of the cervix was published in 1924 although at that time a full 5 years had not elapsed and a follow-up of only 3 years could be obtained in the later cases.

At the present time two reports are in preparation: (1) the cervix cases are being carried to a minimum 5 year end result, and (2) material for a report on cancer of the breast on a minimum 5 year basis is being analyzed. Abstract cards for

three other forms of cancer have been prepared and the collection of records for cancer of the mouth and tongue, cancer of the rectum and cancer of the ovary has been begun. Similar cards for cancer of the colon and of the thyroid are in preparation.

To this very brief statement of the activities of the committee I should add my appreciation of the cordial cooperation which has been obtained on all sides in the arduous and time consuming labor of looking up and abstracting case records and in securing the necessary data on the end results, a burden which falls as a rule upon the younger members of the surgical fraternity, but one which is essential if accurate knowledge of the results of treatment is to be obtained.

That some such accurate statistics of the results of the different methods of treatment of cancer are greatly needed is evident today on every hand. The medical world universally accepts surgery and radiation as effective methods of treatment for cancer, and while a multitude of other methods has been advocated from time to time, none undoubtedly in all good faith and others unfortunately for less worthy motives, none of these other methods of treatment has as yet gained the confidence of the medical profession. Even as regards the value of surgery and radiation there are honest differences of opinion among those well qualified to judge, and it is to secure information for the better appraisal of these methods that the work of this committee has been undertaken.

The past few years have seen a number of advances in our knowledge of the biology and of the pathology of cancer, but the cause or causes are still unknown to us and the prospect of a specific remedy for the disease appears to be as far away as ever. We can go further and state that even if such a specific remedy were to be developed, as in the case of diphtheria or malaria, the problem would still be far from solution for it is well known that even these diseases must be recognized in the early stages if the specific treatment is to be curative.

It is the difficulty of the recognition of the early case of cancer both by the patient and by his physician which is chiefly to blame for its high mortality. That surgery can cope with the

disease in its early stages is abundantly demonstrated in many regions. The fact that from 70 to 90 per cent of cases of breast cancer can be cured if operated upon during the early and local stage of the disease before the axillary lymph nodes are affected is sufficient evidence of the truth of this statement. Unfortunately such early and favorable cases include only about 25 per cent of the cases of breast cancer that enter our general hospitals and the prospect of cure in the other 75 per cent becomes progressively less and less with the longer delay and the wider extension of the disease.

These are the facts which justify the campaign for the education of the public which is sponsored by The American Society for the Control of Cancer. An awakening of the public mind to the recognition of suggestive symptoms and to the danger of delay is undoubtedly the first consideration. This education alone however will not solve the problem. An educated public has a right to demand an educated medical profession and there are too many practitioners who still follow the wait and see policy in a doubtful case and thus permit the disease to extend from the favorable to the incurable stage before their very eyes.

The fact is that cancer today is not a one man job. It requires all the resources and all the professional talent of a large general hospital to deal with the disease in its many situations.

In my own state (Massachusetts) under an energetic public health commissioner supported by the legislature and by a governor who recognizes his responsibility for the health of the community as well as for its material welfare a system of twelve special cancer clinics is being organized in the larger general hospitals scattered throughout the state. In each of these clinics a group of physicians is available who are competent to deal with cancer in all its situations and equipped with material resources to treat all stages of the disease. Such service may be rendered free to the poor patient or a moderate fee charged to those who are not in need of charity. The work of these clinics is co-ordinated with a central state cancer hospital of seventy-five beds which again is equipped with staff and personnel to deal with cancer in all its forms. We

believe that such facilities cannot fail to add to the prompt and effective treatment of the disease in Massachusetts.

With an educated public and with competent professional ability to deal with early and doubtful cases near at hand a great stride has been made in the utilization of our available resources against cancer. Unfortunately however there is room for improvement in the application of treatment both surgical and radiological in many cases. Thirty per cent of the cases of cancer of the breast coming to the Huntington Hospital for treatment of recurrence after operation are found upon investigation to have had performed originally an operation which falls far short in extent of the recognized limits of the radical operation for cancer of the breast. The reasons for the failure of the surgeon to give to his patients the chance every case should have of being cured by radical operation are hard to understand but I suspect that apathy or pessimism as to the probability of cure are the most frequent motives. Inadequate operations of this sort are being performed today in many of our hospitals and it is this fact as much as anything which justifies the segregation of the cancer material of the hospital in the hands of a group of men who are interested and willing to give their whole activities to the welfare of the cancer patient.

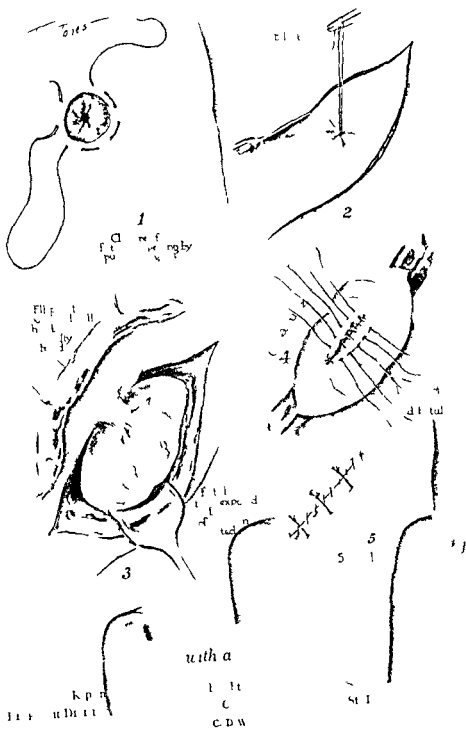
What is true of the surgical treatment of cancer is likewise true of its treatment by X-ray and radium. Not every patient obtains treatment from a radiologist whose greatest interest is in therapy. Many treatments are given with inadequate apparatus and many in a perfunctory manner that offers little advantage to the patient. Especially in regard to radiation therapy it is to be noted the frequent lack of accurate records and of an effective follow up system. It is again these facts which justify the special cancer service in the general hospital where the X-ray and radium therapist can join with the surgeon, the pathologist and the specialists in other branches of medicine in consultation and co-operation with a view to giving to each individual cancer patient the treatment or the combination of the method of treatment best suited to that individual case.



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# SURGERY, GYNECOLOGY AND OBSTETRICS

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## CHRONIC ULCER OF THE DUODENUM AND STOMACH<sup>1</sup>

By JOHN B. DEWITT, M.D., F.A.C.S., PHILADELPHIA

**I**N addition to chronic ulcer of the stomach I will include in this paper chronic duodenal ulcer. I have always considered these conditions most interesting in fact most fascinating. Although it is said that the question of treatment is not settled still I feel that the accomplishments of surgery in treating these lesions are as a rule most satisfactory. I believe that the gastro enterologist, the internist and certain surgeons who lack confidence in their work are to a great extent responsible for the doubt as to the good accomplished by operative as against medical treatment. Personally I can say the longer I practice surgery the more confidence I have in the surgical and the less in the medical treatment of chronic ulcer. The place which I give to the medical treatment of chronic ulcer is that before the diagnosis is definitely established. This statement is based on a study of the non perforative as well as the perforative ulcers on which I have operated. Nearly all of these patients have had medical treatment for years before they came to operation. It is a reflection on the profession that so many people who many times have been pronounced cured of ulcer die from perforation or of hæmorrhage from a chronic ulcer. It is claimed that hæmorrhage from an acute ulcer can be cured under medical treatment. This may be true for a large number of cases but not for all for I have seen patients perish from hæmorrhage from an acute ulcer. It is also

stated that recovery from hæmorrhage due to chronic ulcer takes place in the majority of instances. But again I say this is not always so for I have seen a number of cases that were medically treated to death. What I have just said is neither to discountenance medical treatment nor unduly to praise surgical treatment but to give to each its proper merit. I have operated upon over 100 patients with perforated chronic ulcers nearly all of whom had been treated medically for a number of years. In all such cases there was no question as to the presence of an ulcer as it was seen and palpated in the opened abdomen. I am not one who believes that the X ray is infallible in the recognition of ulcer. I have often questioned the pre operative diagnosis of ulcer on X ray examination and have found at operation chronic cholecystitis with surrounding adhesions or chronic appendicitis or chronic pancreatitis or in a very few instances visceroptosis.

The diagnosis of bleeding ulcer is by no means always a correct one. Confusion may be caused by bleeding from multiple abrasions of the gastric mucosa ulcerating œsophageal varices Banti's disease all of which goes to show that we must be on our guard.

In the last analysis the type of surgical treatment will depend upon the type of ulcer that is whether or not bleeding has occurred and whether or not the ulcer is attached to surrounding structures its location size the



Figs Ch be g t l w th p f t n th l cu t n th pyl ru

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bleeding ulcer is not accessible for safe removal by cautery or excision or when the per ulcerous exudate is too diffuse the operation should consist of amputation of the duodenum below the site of the ulcer and the exudate and removal of the pylorus. It is essential that along with the ulcer all of the per ulcerous exudate be removed and also by careful examination that one make sure that there is not a second ulcer present. In the latter circumstances I prefer a subtotal gastrectomy although ordinarily I do not advocate subtotal gastrectomy except for gastric ulcer.

When the ulcer is on the posterior wall of the first portion of the duodenum its recognition is more difficult. Here we must see well and palpate well otherwise the ulcer will be missed. The recognition of exudate in the gastrohepatic or lesser omentum in juxtaposition to the duodenum is a signpost leading to the site of the ulcer which with the detection of the crater justifies the opening of the duodenum. Then as the margins of the incised walls of the duodenal wound are retracted the ulcer will be exposed. I place great value on the use of the Cameron light in these cases. In fact by this



Fig. 6. Gastric ulcer of the lesser curvature. A Chronic ulcer. B Lines of the lesser curvature.

means I often am able to demonstrate the ulcer to the visitors in my clinic.

If the ulcer is located on the inner pancreatic wall of the second portion of the duodenum only a posterior gastro enterostomy is done but if it be a bleeding ulcer in addition to a



Fig. 7. Anterior anastomosis of the jejunum to rected stomach with a short loop.

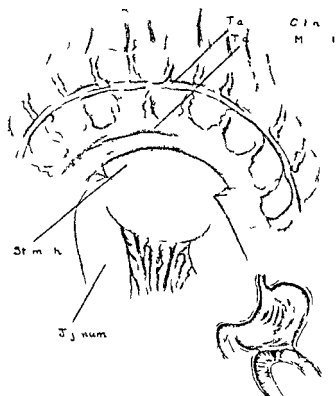
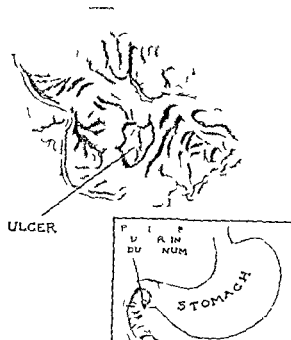
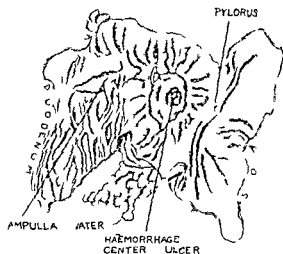


Fig. 8. Posterior gastro enterostomy.



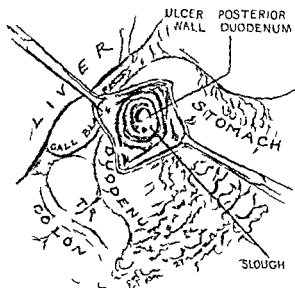
F 1 Duod l c p t e r all

degree and character of the peritrophic exudate the size and depth of the crater. Unless very small the crater is made out by approximating the wall of the vicus opposite the site of the ulcer with the ulcer site. With the finger up the depression constituting the crater can then be readily felt.

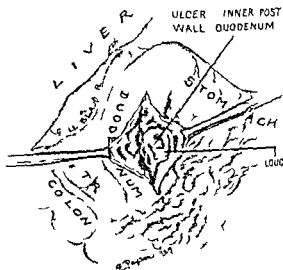


F 2 Duod l c p t e r all

For the small ulcer on the anterior wall of the first portion of the duodenum a posterior gastroenterostomy is usually the operation of choice, but if the operator is skilled and so prefer a Balfour crutery removal or excision of the ulcer and a posterior gastroenterostomy is ideal although some surgeon consider a gastroduodenostomy or a Finney pyloroplasty the better procedure. For bleeding ulcer of the duodenum if accessible crutery de traction or excision followed by posterior gastroenterostomy is the proper method. But when the



F 3 Duod l c p t e r all



F 4 Duod l c p t e r all

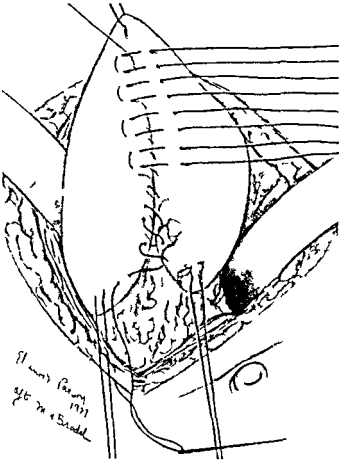


Fig 10a Finney pyloroplasty Step 1

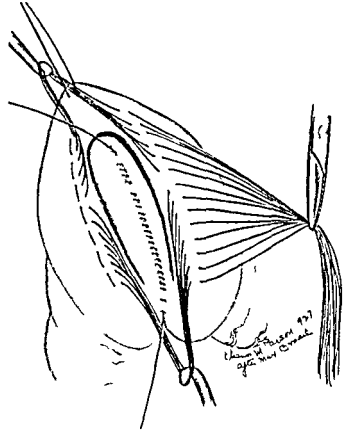


Fig 10b Finney pyloroplasty Step 2

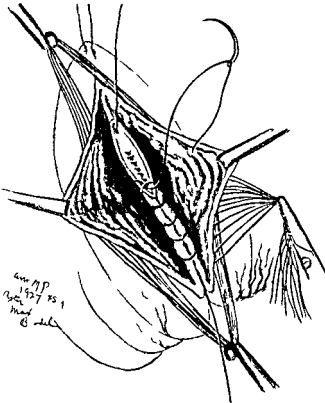


Fig 10c Finney pyloroplasty Step 3

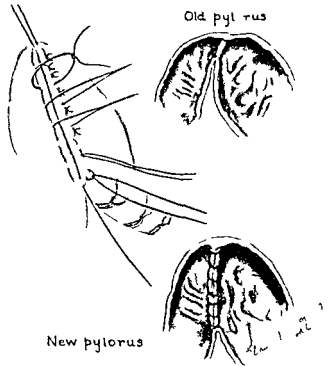


Fig 10d Finney pyloroplasty Step 4

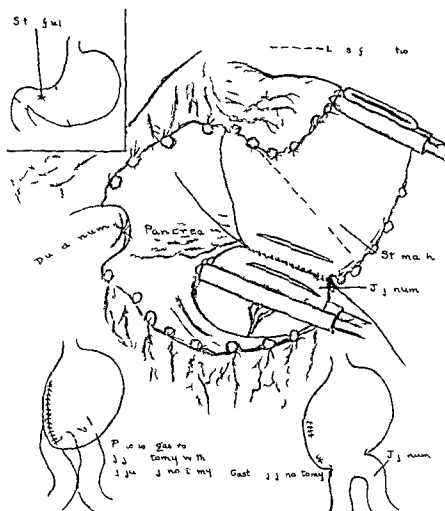


Fig. 9. Billroth II gastrectomy.

posterior gastro enterostomy the duodenum should be opened the ulcer cauterized but no attempt should be made to remove the ulcer.

From what I have said of duodenal ulcer and what I shall say of gastric ulcer it will be seen that in the operative treatment of the duodenal ulcer the surgeon has a greater choice of methods than for the treatment of gastric ulcer.

For gastric ulcer with very few exceptions I advise subtotal gastrectomy. A very small ulcer with little or no per ulcerous exudate located on or near the lesser curvature on the anterior or posterior wall can be excised and nothing more need be done. But if the lesion is on the lesser curvature and has caused hour glass contraction I now on account of the danger of malignancy usually do a subtotal resec-

tion where formerly I made a sleeve resection. Although I have done sleeve resection in a large number of such cases with most satisfactory immediate as well as remote results I do firmly believe that gastric ulcer is frequently enough the forerunner of cancer that I do the subtotal resection a greater safeguard against cancer formation. In doing a subtotal gastrectomy I find it easier to expose and ligate the coronary artery from behind than from above the stomach. This is accomplished by carrying the stomach well upward after it has been freed from the duodenum and the greater omentum. In ulcer of the cardiac end of the stomach posterior gastro enterostomy is the operation of choice.

The preferable type of subtotal resection is the Billroth II operation and if the loops of

THE CONSIDERATION OF CONTOUR AS WELL AS FUNCTION IN OPERATIONS FOR ORGANIC ANKYLOSIS OF THE LOWER JAW<sup>1</sup>

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PREVIOUS to 1871 the common plan of treating ankylosis of the jaw was by forceful stretching or by excision of a section of bone from the angle or body. In 1858 an Englishman named George Murry Humphrey excised an enlarged condyle of the lower jaw. However the operation of excising one or both condyles for an ankylosis is usually credited to Bottini who published his report in 1871 (Fig. 1). Before 1900 almost every conceivable type of operation for this condition had been reported even to removal of the jaw.

This subject is again brought to your attention not in the belief that anything really new will be presented but rather to emphasize certain factors the detailed descriptions of which are rather meager or lacking in the literature and also to bring out a few special points which will be emphasized by citing appropriate cases.

## MECHANICS

Excluding inflammations tumors fractures and muscle spasm chronic limitations of the movement of the lower jaw may be due to (a) fibrous or bony changes of the joint itself (Figs. 1 and 2) (b) change in the shape or bony fixation of the ramus (Figs. 9d and e) (c) scars about the joint or in the cheek (Figs. 6a and b Fig. 9) (d) infringement of a neighboring bony process (Fig. 5) (e) a combination of any of the above factors (Fig. 9).

## OPEN OPERATION VERSUS FORCEFUL MANIPULATION

Though occasional successful instances have been reported forceful dilation of a limited jaw opening of long standing which has developed gradually is seldom satisfactory and is not worth the effort involved (Fig. 1). For permanent relief the cause of the fixation

must be eliminated or modified the more accurate the pre-operative determination of this cause the better and simpler will be the correction. Halfway measures may give relief much more lasting than simple stretching but both are apt to be disappointing. Exposed scar bands should where possible be dissected out and replaced by a skin bearing flap rather than simple incision with inlay Thiersch graft. In attempting correction by operation it is in most cases better practice to remove the upper part or almost all of the ramus rather than to try to reconstruct the joint. The latter is a nice operation but the former is much more apt to be successful.

## EXTERNAL DEFORMITY

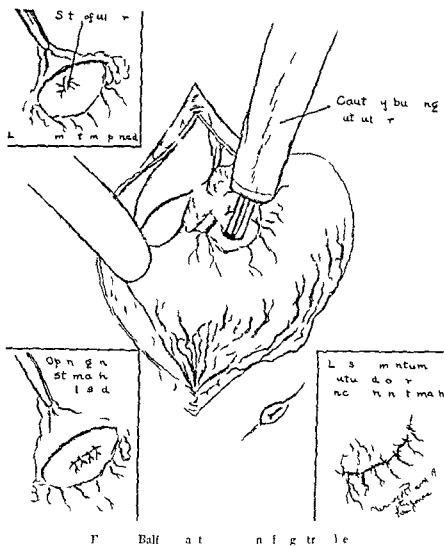
When the ankylosis has existed during the growing period and is due to a fixation within the joint itself whether bony or fibrous there will be some shortening of both the ramus and body on the affected side with a corresponding backward and lateral displacement of the chin (Figs. 3, 18). If the fixation is unilateral and not complete the chin will further deviate to the affected side when an attempt is made to open the mouth. This latter point may be helpful in determining which joint is fixed.

## INCREASED ANTEROPOSTERIOR BREADTH OF THE RAMUS

If the limitation of movement is primarily due to scar bands that fix the lower to the upper jaw the ramus may become abnormally broad from before backward. This might possibly be due to a failure of the anterior border of the ramus to be absorbed as is ordinarily concurrent with the normal growth of the lower jaw. In addition to this abnormal breadth the two jaws may be found fixed to each other by bony union (Figs. 9d and e). If the injury to the soft tissues happens after growth is completed the subsequent scarring does not seem to cause these bone distortions.

See the text of the preceding article in the Journal of the American Medical Association, Vol. 1, No. 1, 1914, p. 167.





F Billroth II

small intestines are left long an entero enterostomy can be done. The Moynihan operation with a short anterior loop bringing the jejunum not far from its origin over the transverse

colon and anastomosing the end of the stomach to the side of the jejunum is probably easier than the Billroth II if a wide resection of the stomach has been made.



Fig 4a



Fig 4f



Fig 4c

1 After the fixed joint is freed the affected side of the mandible may be dragged forward and fixed in this position until the tendency to recede is overcome (Figs 5 7 16 17 18). At first the fixation is made by interdental wiring but later the pull of a rubber band may be used. In unilateral ankylosis with a receding mandible it may be necessary to section ramus of opposite side to get best attainable position of body of jaw (Fig 4).

The receding chin can be built out by means of an implantation of costal cartilage (Figs 7 15 17 18).

3 The facial obliquity remaining after fixing the jaw bone in its new position can be rendered less noticeable by shifting the soft tissues of the chin laterally by filling along the flat side of the jaw with cartilage or by a combination of these (Figs 17a d and e).

#### TYPES OF CASES AND METHODS OF TREATMENT

*Bony overgrowths about the joint—double resection and partial open bite.* A blow on the face (Fig 1) may be followed by an overgrowth of one or both condyles or of the neck and there may be an associated downward growth from the temporal bone. Any of these may distort the joint and limit movement without causing a true ankylosis. It was probably such a case that was originally operated upon by Humphrey. Figure 1 a roentgenogram taken in May 1925 shows such an overgrowth. In 1917 at the age of 10 years the patient was referred to us by Dr C H Clay with a history of previous good health but at the age of 8 years she

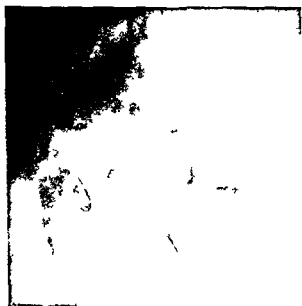


Fig 5



Fig 6a



Fig 6b



Fig

(Fig 11) Elimination of the scars with restoration of the soft tissues soon after injury may prevent this distorting growth of the bones (Fig 12a)

#### RELATION OF CONDYLE TO NORMAL MOVEMENT

While the presence of a normal condyle is essential to the normal development of the mandible and of the temporo-mandibular joint and to normal strength and stability and mobility of the mandible still neither condyle is essential to useful function (Figs 13a and b). The writer's own conclusion is that the lower jaw is hung in such a perfect muscular balance that both condyles can



Fig c

F d

be removed and where desired the jaw can be moved forward without seriously crippling function (Figs 14 and 15). This latter point probably explains the universal success in the restoration of this joint obtained by the simple excision of sufficient bone with or without complicated efforts to furnish a substitute for the necessary joint surface. The writer has always attempted to interpose a fatty flap or superficial temporal fascia not with the idea of placing a barrier between the bony surfaces but to help fill the dead space that is left after removing the condyle (Fig 7).

#### CORRECTION OF THE EXTERNAL DEFORMITY

That a plea should be made for the improvement of contour as well as for the restoration of movement is the chief aim of this paper (Figs 6 to 15). Correction or improvement in appearance may be accomplished by one or a combination of several of the following procedures



Fig



Fig b

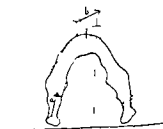


Fig 3 S symphysis S is point to which symphysis would meet if the mandible were a solid block



Fig 97

Fig 98

Fig 99



Fig 9d

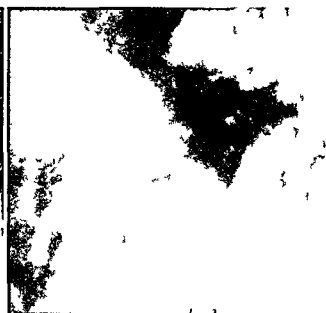


Fig 9e

#### *Direction of rotation in bringing the jaw forward*

Figure 3 is a diagrammatic representation of a lower jaw short from before backward on the left side on account of an ankylosis of the left joint which occurred during the growing period. After fixation was relieved we were able to bring the symphysis forward and to the right by rotating the bone around the center which is at the right condyle. The left ramus will move in the direction of the arrow *a* the symphysis in the direction of the arrow *b*. Note that the symphysis moves forward as well as toward the midline.

#### *Section of the ramus to bring forward the body*

The patient shown in Figures 4a, b and c had scarlet fever and suppuration around the left temporal mandibular joint at 2 years. At 16 years she had extreme recession of the chin and inability to open the mouth. From lack of appreciation of the true mechanics of the condition the writer in February, 1908, cut both rami in two and dragged the body forward. This brought the chin into a better position but did not permanently cure the ankylosis. The result of this is shown in Figure 4a which was taken late in 1908. *V* marks the posterior border

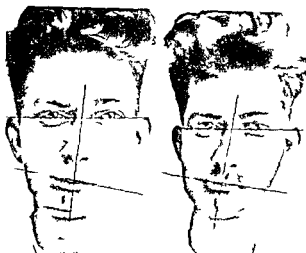


Fig. a

Fig. b



Fig. c



Fig. d

Fig. e

had fallen half way onto her face. Three months before this she could not open her mouth freely and at that time the symphysis was slightly to the right the right lower cuspid being slightly behind the upper. The opening between upper and lower lateral incisor was 1 millimeter the limit of movement was not sharply defined but could be forcefully stretched. In March 1913 the opening was stretched to 3 centimeters and it was 2 millimeters 3 days after this operation. The child was kept under observation for 6 months with no decrease in the opening. She returned in March 1914 with only a suggestion of movement. Both joints were then treated including the condyle and the ossifying bone that arose from around the outer wall of the glenoid fossa. The mandible was dragged forward and fixed for 10 days at which time the intermental wiring was removed. It was found that while movement was not parallel (Fig. 13) because of the elevation of the occlusal surface of the molars the case was a separation of the incisor teeth which would require further treatment.

This is the second case of ours in which after the resection of both joints at once there was a partial opening of the incisor region and both followed early removal of the distal teeth. If the immediate retching of the opening and the return of the teeth will not remedy this it can be corrected by cutting the ramus on each side below the site of the previous operation and then fixing the jaw in occlusion until bony union occurs.

Statistics of the case are as follows: Figures a and b. We have a 13-year-old girl with gonorrhea at birth, culture negative, ankylosis of the left side. Figure a shows the left ramus and damaged joint. Notice that the developing sixth premolar in the ramus and completely distal to the sixth molar in the upper jaw. On the right side the ramus in the recent measurement only 5 centimeters in greatest length. Figure b shows the uninjured side the relationship between the upper and lower premolars about 1 centimeter and the ramus measured 6 centimeters.



Fig. 1a



Fig. 1b

of the upper part of the ramus dragged obliquely forward as the body was advanced. 1 shows the ramus below the bone cut. The bone cut itself is indicated by the light line between these two. The resulting false joint later became fixed and the left condyle was therefore removed.

The proper procedure in this case would have been at the original operation to have removed the left condyle and cut through the right ramus. This would have restored movement and at the same time permitted bringing forward the jaw.

Figure 4b was taken in 1911 and Figure 4c in 1915. A study of the relations of the two last molar teeth will show there was a slight recession of this side of the jaw after removing the condyle. The wire and nail shown at the symphysis in Figure 4a are in a cartilage implant made in September 1908 and in spite of some immediate suppuration the cartilage has remained in place ever since. This type of cartilage fixation is not used any longer.

*Limitation of movement due partially to an over developed styloid process that prevented normal backward excursion of the angle.* Figure 5 is a roentgenogram of a 5 year old patient who was crushed under a falling bale of hay and generally injured. Between the ages of 11 and 12 years it was noticed that she could not open her mouth freely. Examination showed that the excursion of the lower jaw was limited and from that time on the chin became relatively more receding and the downward excursion of the lower jaw lessened. When she consulted us the patient was 17 years old delicate and very thin. The mandible was undeveloped and the greatest possible vertical opening between the upper and lower incisor teeth was one eighth of an inch. Because of the backward displacement of the jaw the lower incisors were one fourth inch behind the upper which with the one eighth inch opening gave

a possible feeding space. We thought that the lack of development was related to the early injury but this did not explain the limited movement which presented the following peculiarities: the movement was free until the opening between the incisor teeth was one eighth of an inch and then stopped suddenly. During this movement the right condyle traveled forward as much as it would do in normal full opening of the mouth. The left remained apparently stationary and the chin moved to the left more than it did downward. This whole picture could be explained on the theory that there was a loose fibrous ankylosis of the left joint and on that side the angle was prevented from moving backward by striking some firm object. A poor X-ray picture the best available at this time failed to throw light on this point.

The indications in this case were to give a free opening of the mouth to establish a better occlusion of the teeth and to improve the profile by carrying the chin forward and holding it there. The ramus were sawed transversely on both sides and the body of the jaw brought forward until the lower incisors were a little in front of the uppers and the chin

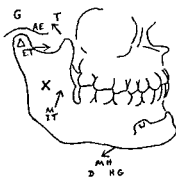


Fig. 13a

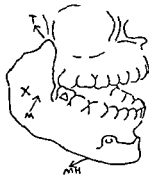


Fig. 13b



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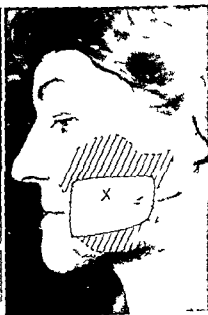


Ind at lmt f Tl r hg st

/ / / / Ve ft d

X O l flap th t as pla l th t  
r p ly— O t l ne f ma d bl l t br sth  
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d l t

I r a



F b



Fig. 1a



Fig. 1b

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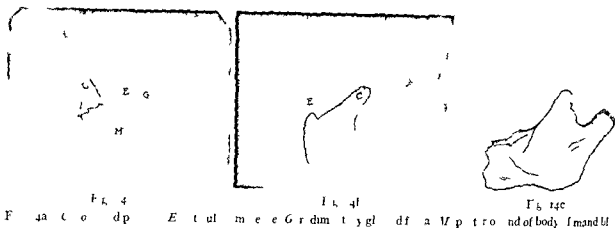
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Fig. 13b





symmetrically placed. It was wired in this position. In 4 weeks the union was examined and found not to be strong so the teeth were rewired for 8 weeks more. When the wires were removed from the teeth it was found that the mouth opened freely one half inch and that the limit of movement was some yielding structure. Examination 1 year later showed that the lateral movements were normal and the possible opening between the incisors was seven eighths of an inch which is sufficient for good function.

A good roentgenogram taken some years after the operation showed that the styloid process on the left side was almost the size of her little finger and at full opening abutted against the inner side of the angle of the jaw. It also showed a change about the left joint that suggested at least a fibrous ankylosis. This corresponded with the original deduction. When the body was moved forward a space was obtained between the angle and the styloid process which gave room for the angle to tilt backward and approximate normal movement.

Another patient had an arthritic fixation of the cervical spine with the head bent slightly forward but even after the resecting of both condyles the extension of the mandible was still quite limited by the chin striking against the thyroid cartilage.

Since about the joint preventing forward replacement. Unless the jaw is dragged forward and an interlocking occlusion established the removal of the condyles will not correct the backward position of the body of the jaw (Figs 61 and 62).

Figure 6a shows a child 5 years of age with a close fibrous ankylosis of both joints with a good deal of periarticular scarring all due to an early infection of some kind. At operation both condyles were resected but on account of the scarring in the soft parts it was impossible to move the body of the jaw forward.

Figure 6b shows the same child 1 year later at which time she had a functional opening of the mouth.

Figure 7a shows a child with an early unilateral ankylosis. At the age of 6 years this patient (Figs 7a, b and c) had a tooth infection and necrosis of the jaw on the right side. At 24 years when he came for treatment the most noticeable points were lateral prominence of the body of the jaw toward the ankylosed side with corresponding flattening on the opposite side, deviation of the chin lips and nose toward the affected side, the obliquity of the mouth's angle compared with a line drawn through the alveolar fissures. The patient's correction here

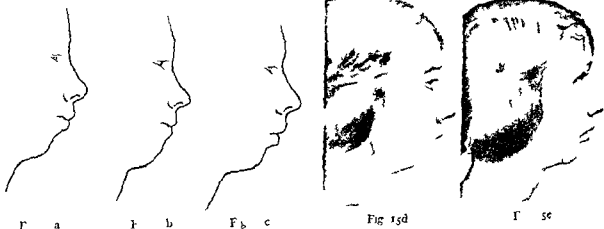




Fig. 15f

Fig 15f M mastoid process G glenoid fossa A articular eminence N rudimentary neck S sigmoid notch C coronoid process

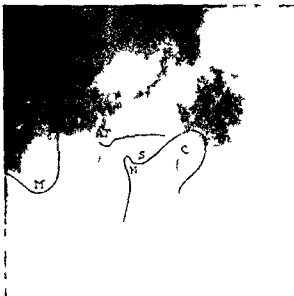


Fig. 15g

shown was made by removing most of the right ramus and rotating the jaw bone to the left shifting the soft tissues of the chin still farther to the left and implanting a cartilage. In this the first case in which we attempted to move the soft tissues on the bone the chin was brought to correspond almost with the axis of the nose as shown in Figure 7b. A more acceptable result would possibly have been obtained if the chin had been brought nearer to a vertical line dropped from the mid point between the brows at right angles to the axis of the palpebral fissures as was done in Figure 17e.

Figure 7c shows the large amount of the ramus that was removed to permit bringing forward the right side of the mandible. In the case shown in Figure 17 it was necessary to remove a still larger part of the ramus including that part which held the roots of the third molar before the mandible would clear the upper molar teeth. This large removal of the ramus seems to cause no functional inconvenience in a single resection but I believe it not permissible in a double ankylosis. In the latter case I believe it is desirable to retain the coronoid process and temporal muscles.

**Lateral deviation.** A child 11 years old (Figs 8a and b) who at 4½ years had meningitis following which partial ankylosis gradually developed. Figure 8a shows the full extent of the opening when he came for operation. Figure 8b the possible opening 16 days after removal of the condyle and upper half of the left ramus but this opening should increase considerably in the next 3 months. The point brought out in this illustration is that the tendency when the mouth is opened for the chin to deviate to the resected side still persists.

**Scar fixation—late results.** A woman 38 years of age (Figs 9a, b and c) was referred to us by Dr W. C. Drummond. At 11 years she had probably

normal and lost part of the cheek left upper lip lining of the cheek and part of the left upper jaw bone when it healed she could not open her mouth. Figure 9a shows condition February 1915 with mouth open to the fullest extent 4 millimeters between upper and lower incisors. Figure 9b shows the extent of the opening after the removing of the upper end of the left ramus the removing of the cheek scars and the replacing of lining and external cheek tissues with flap from forehead. The mouth would open December 12 1924 centimeters between incisors but this has increased since. Figures 9b and c were taken February 13 1925. Figure 9d shows a normal joint but a somewhat wide ramus and coronoid after 7 years of almost complete fixation. Figure 9e shows the left the injured side



Fig 16a

Fig 16b



F 16c



F 61

with only relative growth changes about the joint itself but with tremendous widening of the ramus and posterior part of the body. Originally the bony mass at the outer border of ramus on one of the posterior part of the body had acquired bony union with the mandible but this was shattered through at the original operation in 1918 by Dr. A. O. Fisher and had not reunited. The joint changes shown on this side in this figure were a relatively small condyle and a very deep narrow glenoid fossa with a correspondingly high articular eminence. In the note on the 1918 operation it is stated that after cutting the scars and cutting the bony union between the two jaws the mouth could be forcefully opened 3 centimeters and was blocked in this position but in 1934 after cutting all the reunited scar bands we were not able to open the mouth until the joint and upper half of the ramus were removed.

**Surgical treatment—late result.** In Figure 3 is the photograph of a woman referred by Dr. H. P. Shand who in 1923 was 2 years of age. At 13 following typhoid fever she had a noma which destroyed the lining and considerable of the surface of the left cheek. Following this she could not open her mouth. Some time later the lining had been removed and the cheek lined with a flap turned from the neck, but she stated it did not relieve the fixation. When first seen by us in March 1933 she had an opening between the incisors of 6 millimeters. Fixation apparently due to a scar band in front of the cheek lining that had been obtained from the neck at the previous operation. However a functional opening was not obtained until the abnormally wide ramus was removed and the cheek lining freed out and the buccal and labial sulci were restored by means of thick Thiersch grafts inserted on 3 wax forms. Figure 4 shows the result by the original cheek flap. The shaded area shows the amount of lining that was obtained from the Thiersch grafts but there is still a considerable contraction

of the ethan free grafts for which provision has been made. The dotted line shows the profile of a bone bringing out the increased antero-posterior width of the ramus.

The lower lip was subsequently raised by a flap, thrown under the chin. Still further correction was done later by Dr J. E. Johnson of Memphis.

S ar p r i t i o n - l a t s h i s F i g u r e 1 a s h o s a  
 o m a n 3 6 y e a r s o l d r e f e r r e d b y D r R o y a l W a i g h t  
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 n r i n e c t e l t o o t h i n t h a c u t s t 6 o f t h e i n f l a m  
 m a t i n s h e h a d r e c o s t o f t h e b o n c s a n d c o n  
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 a n d c h i n a s h o n i n F i g u r e 3 a

*Dee* *el* *k* *sea* *s* *e* *using* *k* *i* *his* *i* *g* *re* *s* *a*  
*an* *l* *b* *sho* *a* *ch* *ld* *o* *f* *8* *y* *ars* *i* *n* *h* *m* *a* *ter* *a* *g* *a* *n*  
*gre* *nous* *stomat* *itis* *a* *t* *5* *e* *r* *an* *l* *s* *e* *e* *a* *l* *me* *t* *ect* *ive*

Ob S g l e f h l g f h ou h g G<sub>2</sub> re d



Fig 1 a



Fig 1 b



Fig 1 c

operations the upper and lower jaws remained bound together by scars throughout the substance of the cheek that extended from the anterior border of the ramus to the cuspid region. In this patient the restoration of the cheek was made before serious changes in the shape of the bone had occurred and therefore no bone operation was necessary to restore movement.

**Paradoxical movement** In Figure 13a we show a diagrammatic representation of the normal jaws  $\Delta$  indicating the axis of motion in the simple opening and closing  $G$  glenoid fossa and  $I F$  the articular eminence which together indirectly form a bearing or guide for the condyle during this movement  $I$  approximately the direction of pull of the temporal muscle in closing the jaw  $I F H$  approximately the direction of pull of the internal pterygoid and masseter muscles in closing jaw  $E F$  approximately the direction of pull of the external pterygoid in opening the jaw  $M H D$  and  $H G$  approximately the direction of pull of the mylohyoid digastric and geniohyoid muscles in opening jaw. If  $C A F$  is a bearing then the  $\Delta$  on the condyle would represent the fulcrum the arrow  $M I I$  approximately the power and the teeth the load of a lever of the third class. This is approximately true in ordinary movements of the normal jaw. If a bearing for the condyle at  $G I E$  were essential to this motion then on removal of the condyle the molar teeth being present the mandible would be converted into a lever of the first class with the load anterior to the fulcrum ( $\Delta$ ) and the power  $M I I$  behind the fulcrum contraction of the muscles of mastication would then draw downward that part of the jaw that is in front of this new fulcrum. In this condition  $\Delta$  the axis of movement and  $\Delta$  the fulcrum

correspond. On these theoretical grounds we long hesitated to remove both condyles in a double ankylosis until the analysis of reported cases showed that it was not always followed by open bite. It is something of this fear that probably causes men to limit the operation to those cases in which the joint can be reconstructed—an operation less apt to be successful than is a free removal of bone and also it is an operation with a very much more limited field of accomplishment. Our own subsequent experience has shown that these theoretical fears are not entirely groundless. If both condyles are removed at one operation and the upper and lower teeth are not fixed together contraction of the masticatory muscles will cause an opening between the incisor teeth and permanent open bite may result. We have had this happen in cases when the

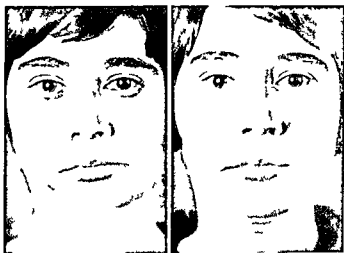


Fig 1 d

Fig 1 e



Fig 8a

Fig 8b

dental fixation was removed at the end of 3 weeks. In 1 child however in which the condyles were removed at 8 months (Fig 14) due to lack of teeth no fixation of any kind was used and no paradoxical movement resulted. In other cases in which dental fixation was retained sufficiently long 8 to 12 weeks a muscular balance was established that can closely simulate normal movement even when there is no bony contact between the mandible and skull behind the occluding teeth; the axis of motion remains approximately normal.

**Muscular balance.** In Figures 14a and b are X-ray pictures of the ramus and joint regions of a child who 5 years previously at 18 months of age lost both condyles from infection following bilateral fracture at the junction of the necks with the ramus.

Figure 14c is an outline drawing of an average 8 months mandible showing the lack of development of the ramus at this age and also the approximate line of the fracture in this case.

In Figures 14a and b roentgenogram taken 5 years later it will be seen that following the loss of the condyles there has been little or no subsequent development of the ramus and though the coronoid processes have become abnormally long so that the tips approximate the normal point of insertion of the temporal muscles these long coronoid processes have failed to migrate backward to a normal extent as proved by the shortness of the body and also by the fact that the twelfth year molar is seen developing in the base of each.

In this child the body of the lower jaw is in a somewhat posterior position but she can open and close her jaw to either side and chew her food satisfactorily but as demonstrated by the X-ray picture she has no bony contact between the mandible and the base of the skull. The chief disability resulting from this condition is that neither the patient nor one other similar one can sleep lying on the back for then the muscles being relaxed the jaw with the tongue drops backward and shuts off the pharyngeal air way.

**Second case illustrating a functional residual without bony contact.** Traced profiles of a girl who at 7 years had an auto injury leaving a scar on the chin and was never afterward able to open her mouth are shown in Figures 15a, b and c. When referred for treatment in August 1915 by Dr. A. H. Hammel



Fig 8c



Fig 8d

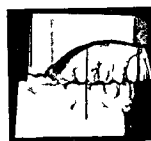


Fig 8e

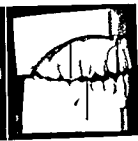


Fig 8f

she then 3 years of age had a complete bilateral bony ankylosis with typical retracted lower jaws as shown in Figure 15a. Both condyles were removed and the dead space was filled with flaps of fat and fascia from the temporal regions. At the same time the body of the jaw was drawn forward until the lower incisors were 4 millimeters in front of the upper and the jaws thus fixed by interdental wires. This gave the immediate profile (Fig 15b). The interdental wiring was retained for 12 weeks and when the fixation was removed she had all natural jaw movements but these movements were not all normal. At a later period Dr. L. R. Main extracted the first lower premolar on each side and drew back the cuspid and incisors into normal occlusion with the opponents. This gave her a rather acceptable facial outline but with later growth the lower jaw failed to retain its harmonious relation with the upper and at 8 she again had a relatively receding chin as seen in Figure 15c. Five years after the first operation she had an opening of 6 millimeter.

Figures 15d and e show the same girl at the age of 18 years before and after inserting a piece of coal catilage in front of the mental eminence.

Figures 15f and g are from stereoscopic X-ray films of the right joint region and g the left. In the mastoid process C the glenoid fossa I E the articular eminence V the rudimentary neck of the amputated condyle S the sigmoid notch C the abnormally large coronoid process. Comparing the area with corresponding area in Figures 14a and b it will be observed that a subnormally developed ramus is present in the child who as injured at 7 years while it is entirely absent in the child who lost her condyles at 18 months. Further that while in the younger child at the age of 6 years the twelfth year molar is developing in the base of the coronoid in the girl of 18 years who as injured at 7 and lost

S. Theoy. f m f th m f H Bl S ry  
d D f h M th d J s

her condyles at 13 the third molar has erupted in front of the ramus (and base of the coronoid)

In the stereoscope it is very easy to verify all of these points. By noting the relation of the ramus and the condylar neck A to the glenoid C and the eminence F it will be seen that the jaw has no bony bearing on the base of the skull and that it has remained in the forward position given to it at the ankylosis operation 3 years previously. The movements are similar to those described under Figures 141 and b<sup>1</sup>.

**Preangular notch.** Retraction of the chin is rather a constant accompaniment of an ankylosis developed during the growing period and is often much more pronounced when the face is viewed in profile than would be indicated from the occlusion of the teeth (Figs 161 b c and d). On the other hand facial symmetry is extremely variable.

This 15 year old girl had a fall at 5 years and 6 months later it was noticed that the mouth did not open freely. After the left joint was resected the jaw was swung to the right until the symphysis was brought to the midline. This helped the profile very little and 16 days later a cartilage implant was made into the chin. In making these implants we usually use a piece of the left eighth costal cartilage preserving as much of the perichondrium as possible. Figures 16a and b show the profiles before the first operation and after the cartilage implant. Figure 16c shows the normal joint ramus and angle. There is a characteristic notch at the lower border of the jaw just in front of the angle on the ankylosed side whether it be single or double (Fig 16d). In almost all cases of partial single ankylosis the chin deviates toward the ankylosed joint as the limit of excursion is approached. In this case for some unrecognized reason the latter sign was absent and there was no thickening to be felt about the affected joint but in spite of all this and without an X ray examination one could have recognized in this case which was the affected joint by the presence of the notch on that side. This roentgenogram shows the broad contact of the fibrous ankylosis the shorter ramus and the characteristic notch in front of the angle.

**Correction of external deformity.** For putting all one has into a case one may be amply repaid (Figs 17a b c and d). This young lady referred by Dr A B Kanavel came at the age of 18 with the history of scarlet fever and discharging ears at the age of 4 months and a left mastoid operation at 7 years. Six months later the mouth opening was limited and the chin already deviated to the left. She had had orthodontic work for 10 years and had one fat transplant into chin as evidenced by the scar in Figure 17a.

Th b th p th mo m t f th m ndabl m f  
dyles h bee th p bject f t dy by f mb f  
g d th d b p es ted w f m t d q t som t m  
r d t se m d t b f m d b th m m t d y  
h ml t f h w Fig 5 b th r p bl t as w th  
h la tu th f m t r y w th compl t t d b  
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Figures 1, a and d show the characteristic deformities. In order to get clearance for moving that side of the mandible the whole of the left ramus was removed and the jaw was then shifted as far as possible forward and to the right where it was held by interdental wiring. Two months later through an incision made just under the chin the thickest obtainable piece of cartilage was implanted in front of the chin and a long wedge shaped piece slid along the right side of the body the soft tissues at the same time being shifted to the right and sutured in this position.

Figures 1, c and e show the result. Notice the mouth line has been made horizontal the chin is approximately in the midline the left cheek is less prominent and the very deforming flatness on the right side of the lower jaw is almost obliterated.

Figure 1, a shows the profile before the joint resection and the scar of a previous operation.

Fig 1, b superimposed tracings made from the negatives showing the condition before the first operation after bringing the bone forward and after the cartilage implantation. Notice in Figure 1, c how the lower lip and corner of the mouth have been lifted. When she left the city she had an incisor opening of 2.5 centimeters which will still further improve. The space between the lower central incisors was 3 millimeters to the right of the midline above.

**Correction of external deformity.** Figure 18a shows the appearance of a young man who had rickets in infancy but there was no evident causative factor for ankylosis elicited. At 16 years of age he went to an orthodontist and it was found that he could not open his mouth freely. The facial asymmetry became more evident with subsequent growth. When referred to us by Dr C A Thigpen of Montgomery Alabama he was 20 years of age. The chin was well over to the right as shown in Figure 18a and there was a free opening between the upper and lower incisors of 1.5 centimeters. The chin was quite receding. An X ray picture showed fibrous ankylosis of the right joint. At operation June 4 1924 most of the right ramus was removed and the jaw dragged forward and the jaws fixed with a pine block between the upper and lower molars on right side with an incisor opening of 3 centimeters. Block and wiring were removed 16 days later and subsequently Dr J H Williams put on an orthodontic appliance with a rubber band that drew the right body farther forward and to the left than it was when the block and wires were removed. Figure 18b shows appearance 4 months later. His chin and mouth are still slightly to the right but if a cartilage were implanted the soft tissues would be shifted to the midline as was done in Figure 17 and his profile much improved. Figures 18c d e and f show the amount of shifting of the lower jaw that was accomplished by dragging the right side of the body forward at the time of the ankylosis operation.

COLLOID CARCINOMA OF THE STOMACH<sup>1</sup>By JOHN W. STINSON, M.D., F.A.C.S., ROCHESTER, MINNESOTA  
The Mayo Foundation

**B**RINION was the first to make a statistical investigation of gastric carcinoma. He reviewed much valuable data from various sources and published his records about 1857. His analysis of these cases is of considerable value even today.

Much doubt has existed concerning the relative malignancy of colloid carcinoma. It has been designated variously as mucoid, gelatinous and myxomatous and may occur normally in every organ producing or capable of producing mucus. The most common sites of colloid carcinoma are the stomach, large bowel and appendix but occasionally it occurs in the gall bladder, bronchus, breast, ovary, cervix, urinary bladder, kidney and salivary glands.

Certain investigators regard colloid as a consequence of degeneration and others as a secretion but the latest and most accepted view is that it comes from the epithelial cells of the carcinoma. This has been particularly noted both in the primary and metastatic growths. My studies seemingly corroborate this and also seem to show that the colloid originates from the epithelial cells as a secretion and is not a result of degeneration. There are many instances of specimens from carcinomata showing isolated areas of cells with a small amount of colloid formation and many of the cells themselves may be seen to contain colloid, the nucleus being pushed to one side giving a ring-like appearance. Some of the cells may have ruptured showing that the colloid apparently caused too much pressure. The finding of small deposits of colloid in the epithelial cells of carcinoma and in no other cells of the tumor suggests its probable origin from epithelium.

Colloid in carcinoma is said to be a mixture of mucin and other proteins derived from cell degeneration and vascular exudates. Wells says that mucin appears chiefly in two localities in the epithelial cells as a product of secretion and in the interstices of connective tissue, especially of tendons. There is also

evidence that mucin or a related body constitutes the cement substance between the body cells. Corresponding to the two chief sources of mucin, mucoid degeneration occurs as a distinct process in mucous membrane or tissue derived therefrom and in connective tissue.

Wells further states that in its typical form mucin is a compound protein consisting of a protein radical and a conjugated sulphuric acid which contains nitrogenous sugar. It is acid in reaction probably because of the presence of sulphuric acid and when boiled with acid yields a substance which reduces Fehling's solution. It is characterized microchemically by staining with basic dyes. It is readily dissolved in weak alkaline solution and is precipitated by acetic acid.

Epithelial mucin represents a distinct product of specialized cells. Mucin formation of catarrhal inflammation is merely an excess of normal secretion and degenerative change that may be present in the epithelial cell. Even in the extreme example of mucoid change seen in carcinoma, derived from mucous membrane, for example, colloid carcinoma the epithelial change is not necessarily to be interpreted as a conversion of cells to plasm into mucin but is largely due to pressure of secreted mucin on the cell within the confined space of the tumor. This mucin is the same as the normal mucin coming from the same source but mixed with larger or smaller quantities of other proteins derived from cell degeneration or from vascular exudates.

From March 1913 to May 1, 1923, there were 516 pathologically proved cases of carcinoma of the stomach examined at the Mayo Clinic and of these 121 were of the colloid variety, the latter form the basis for the present study.

## INCIDENCE

The following data, beginning with Branton's first statistical studies and including some of the largest series studied by various

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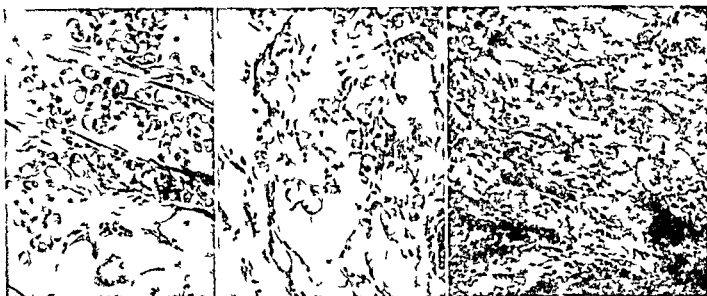


Fig. 1. Signet ring cell of colloid carcinoma ( $\times 150$ )

Fig. 2. Area of colloid and a few signet ring cells ( $\times 10$ )

Fig. 3. Diffuse infiltration of colloid carcinoma ( $\times 10$ )

observers give the incidence in relation to the other types of gastric carcinoma as well as to other malignant growths of the gastrointestinal tract. In Brinton's series of 135 cases of carcinoma of the stomach 9.4 per cent were of the colloid type. Welch in a review of 121 malignant growths of the gastrointestinal tract noted colloid carcinoma in 5 per cent and von Klein in 395 cases noted the colloid variety in 5 per cent. Pirham in a review of 784 cases of gastric carcinoma found them in 6.5 per cent. In my series of 2516 cases of gastric carcinoma colloid changes were found in 5.09 per cent. In all of my cases the tissue examined microscopically was obtained at operation or at biopsy, thus all cases were verified pathologically.

#### SYMPTOMS

There was nothing in the histories that could be used to differentiate with any degree of accuracy the colloid carcinomata from other types of gastric carcinoma. Exploratory operation and microscopic examination of tissue offer the only sure method of differentiation. The average length of time (pre-operative) that patients in this group complained of symptoms was 8½ months.

#### SEX AND AGE

There were 25 women and 96 men in the series. The average age of the women was 50.5 years, of the men 53.3 years; the general

average was 57 years. The oldest patient was 79 and the youngest 31 years of age.

#### PATHOLOGY

The structure of colloid carcinoma of the stomach is similar to that of ordinary adenocarcinoma except that a great deal of thin mucus is present. Many of the lesions especially the larger ones when first viewed at operation are readily recognized because the colloid material is frequently subserous. If the serosa is involved the surface over the lesion presents the small clear tapioca-like masses which are typical of this variety of carcinoma. The stroma is translucent and gelatinous either colorless or light brown. The lumen of the stomach often presents a large flat ulceration and in the smaller ulcerations where colloid is not so prominent the craters are frequently deeper. Here is seen a distinct alveolar grayish framework which encloses the colloid granules. In the typical cases all of the wall of the stomach from mucosa to serosa is almost completely changed by the presence of colloid material so that the cut surface is clear and gelatinous and of a soft friable more or less mushy consistency. In these cases practically all of the involved area of the stomach is replaced by colloid which frequently produces a somewhat honey-comb effect.

There were no complete perforations in the series of cases studied; instead the whole wall





Fig 4 Isolated nests of colloid material with a few giant cells ( $\times 100$ )

of the stomach was usually thickened as in the scirrhus type of carcinoma. Even in the smaller deeper ulcerations the danger from perforation seemed negligible. When the craters were deep and the gastric wall therefore somewhat thinner the adhesions and thickening immediately surrounding made danger from perforation improbable. There seemed to be a constant regenerative process about the areas of ulceration and destruction.

Most of the lesions were situated at or near the pyloric end of the stomach but many of them were so large that the ulceration extended past the middle of the stomach. In many of the typical cases the line of demarca-

tion of colloid and normal appearing tissue was very abrupt. Grossly the colloid appeared to have destroyed the normal tissue or substituted tissue in its place. Often the muscle of normal consistency up to the edge of the cancer then it appears to be completely changed to the colloid type.

The stomachs showing colloid on the serosa were for the most part those containing the larger lesions. In some cases the colloid was plainly visible when the stomach was opened or was presented grossly on the mucous surface when there was no indication of its presence on the serous surface.

Colloid changes may be noted in the earliest stages of the carcinomatous process and are frequently found on microscopic examination when not visible grossly. This is true particularly of the smaller ulcerations when there is a question of simple benign ulcer or carcinoma. The association of ulcer and cancer is so frequent that the possibility of malignancy should always be considered with any ulceration of the stomach. MacCarty (6) believes that most chronic gastric ulcers with a diameter of 5 centimeters are cancerous. Grossly the colloid ulcerations vary from 1 to 14 centimeters in diameter. Some are rather small lesions that appear as simple benign gastric ulcers and their true nature can be detected only by microscopic examination. There are no instances in this series of cases in which



Fig 5 Large hollow tumor with thin wall destroyed by colloid material



Fig 6 Deep rat-hewn ulcerations with colloid material

cancer existed without some evidence of its presence in the mucosa.

At operation many cases showed general carcinomata is metastasis taking place in other types of gastric carcinoma but in addition colloid globules were often found. In many instances the omentum was so extensively affected as to be thickened and board like.

On microscopic examination typical colloid carcinoma presents a fine connective tissue glycolar frame work containing a transparent mucocolloid mass. There may not be cellular elements but usually a number of cells or cell fragments are found. In many specimens the cells themselves are filled with the colloid material the nucleus being pushed to one side giving a signet ring appearance. Frequently many cells are seen in a swollen condition and containing hyaline granules.

In certain cases colloid is found only after diligent search and then in small amounts in isolated areas. Some of the more typical colloid carcinomata present a honeycomb appearance the larger part of the tissue being completely replaced by colloid material. Colloid appears to stream out from the mucosa to the serosa carrying everything before it. It may be so much in prominence that practically no cells are contained in the meshwork enclosing it. Some areas show meshwork broken as if from the pressure of the colloid within pushing its way between other structures and causing more destruction.

In some specimens the colloid is found in isolated areas with many signet ring types of cells whereas a little further away the signet ring variety disappears and the typical adenocarcinoma type prevails without evidence of colloid formation. These malignant cells entirely without colloid production may account for the reported instances of metastatic recurrence in which colloid could not be demonstrated. These cells are the most malignant and therefore might have a greater tendency to metastasize. Another possible explanation for the areas of metastasis in which there is no colloid may be found in the results of the experiments of Lim and Crile.

Lim in his studies on animals found evidence to show that the gastric glands are in

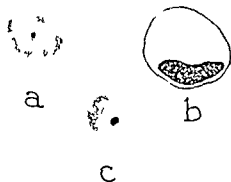


Fig. 7. Normal regenerative cell a signet ring type of cell frequently present in colloid cancer b malignant cell c

the first instance formed of non mucoid cells. Later these cells become mucoid throughout the stomach. The next type to differentiate is the oxyntic and at a later stage the peptic. Peptic cells are present in the stomach of the human fetus at birth. Obviously pepsin is not secreted by the mucoid cell.

Crile found that oxyntic cells disappear and peptic cells lose their granules in the vicinity of gastro enterostomy openings and all the cells appear to be mucoid in character. He inferred from this that the altered conditions had caused the specialized cells to revert to the more primitive mucoid cells.

From the foregoing one might also infer that possibly some of the instances of metastasis in which colloid could not be demonstrated might mean a reversion to the primitive or non mucoid cell.

#### TREATMENT

Brinton in 1857 said "Of the treatment we will speak little because there isn't any of any value. The first step toward any plan of treatment was made by Perrin a Frenchman in 1879 who removed the pylorus and the patient died. The first successful pylorotomy was performed by Billroth in 1881 and from this success came the first hope with regard to the treatment of carcinoma of the stomach.

In competent hands the operation of partial gastrectomy for carcinoma can be accomplished with a mortality rate of less than 10 per cent. In cases in which there is no operative interference the mortality rate so far as we know is 100 per cent. Operation affords the only chance and in the proper surroundings should be undertaken. The earlier the

growth is seen the better is the chance of a cure

#### OPERABILITY

After the general condition of the patient has been considered and the proper preoperative measures carried out in order that an operative procedure may be undertaken with the least possible risk the vital question arises. Can all of the growth be removed? A thorough knowledge of the usual metastatic routes of gastric carcinoma is most essential before any type of treatment is instituted. If there is no external evidence of extension of the process especially the evidence most frequently recognized clinically such as supraclavicular lymph nodes of the left side umbilicus rectal shelf and chest and metastatic areas are not detected on palpation of the other viscera a thorough exploration of the abdomen must be made after the stomach has been exposed and the diagnosis verified. The viscera especially the liver peritoneum and pelvic organs should be carefully examined for nodules and then a most sedulous investigation made for lymphatic involvement along the usual routes of lymphatic drainage from the stomach.

Movvhan gives an excellent account of the lymphatic drainage from the stomach the usual sites being classified as primary and secondary. Primary represents the lymph nodes immediately around the stomach for example the lower and upper coronary the right paracardinal suprapyloric right suprapancreatic gastroepiploic upper and lower and the retroperitoneal when present. Secondary represents the lymph nodes more remote from the stomach if these are involved the condition may be regarded as inoperable.

Primary lymphatic involvement is the most important to the surgeon because these lymph nodes receive vessels directly from the stomach and should be removed with the growth. Lymphatic invasion occurs early in gastric carcinoma and usually along the lesser curvature. The most important of the secondary lymph nodes are those around the celiac axis because they are the recipients of afferent vessels from all the groups previously described. They are few in number large in size

and lie in the fork formed by the coeliac and splenic arteries as they arise from the celiac axis. Some of them pass behind the pancreas to the lymph nodes lying at the root of the mesentery and if involved are readily palpable.

In a case in which the lymphatics appear to be more involved than usual but in which the case is otherwise operable a microscopic examination of the nodes is often of service because they are frequently found to be inflammatory hence what would appear to be an inoperable condition is sometimes found to be quite the opposite. The early and wide extension into the submucosa is clearly seen in sections of the margin of the growth and for this reason the excision should be wide of the margin never under 3 centimeters.

In this series of 121 cases of colloid carcinoma 91 (80 per cent) were found to be operable and the growth was removed. Nineteen were inoperable and 5 were suitable for palliative measures.

#### PROGNOSIS AND RESULTS

The postoperative course was studied as far as possible and the results in the colloid varieties of carcinoma compared with those of other varieties. According to MacCarthy data from which a prognosis may be made are largely compiled from statistics based on the average length of life from the time the physician or surgeon sees the patient. At best it is based on impressions and certain personal opinion since there are so many variables and unknown factors in the problem. In general one considers size of growth cellular character of growth age of the host duration of the lesion relation of growth to nutrition emaciation in relation to food intake proximity of growth to vital structure lymphatic involvement (regional and distant) distant organic metastasis multiplicity of the lesions character of previous treatment and the morale of the patient. The influence of these factors is purely relative and general.

MacCarthy (6) further states that microscopically there are four important factors bearing on the prognosis: lymphocytic infiltration fibrosis by fibrosis and cellular differentiation. He found in an analysis of

200 cases that lymphatic involvement decreases the chances of postoperative longevity. The younger the host the shorter the life expectancy after gastric resections regardless of lymphatic involvement. Differentiation increases the chances of postoperative longevity. In cases of gastric carcinoma without lymphatic involvement or extensive lymphatic infiltration the greatest average length of postoperative life occurs. Differentiation and lymphatic infiltration combined greatly increases the average postoperative life expectancy. The size of the regional lymph nodes bore no apparent relation to the size of the primary lesion in the stomach.

All of the specimens from the colloid carcinomata were studied grossly as well as microscopically and anything that might have a bearing on the prognosis was carefully checked against the clinical course (Figs. 1 to 7).

The immediate postoperative mortality was about the same as in other types of gastric carcinoma. It was found that in cases in which there was lymphatic involvement postoperative life was shorter.

Specimens showing colloid on the serosa were compared to those in which there was none and it was found that the colloid regardless of lymphatic involvement had increased postoperative life expectancy. Colloid material is apparently a sign of partial differentiation. It appears to destroy the cell or to have that tendency thus lowering the chances of its being so large a factor in recurrence.

The size and depth of the lesion does not appear to be of prognostic import. The presence of the signet ring type of cell did not seem to influence results. According to Pirham its presence in the caecum usually means shorter postoperative life.

The prognosis in cases of young patients showing colloid changes was not good. It was much better in those in which no such changes were noted. As a rule the younger the patient the shorter the life expectancy following operation.

The percentage of patients whose postoperative life was 3 and 5 years averaged about the same as in the other types of gastric carcinoma but the chance of living longer

than 5 years was found to be less in cases in which specimens showed colloid changes. From this it appears that the colloid type of carcinoma although it may grow more slowly is more prone to late recurrence. There is not the tendency to fibrous tissue encapsulation in this type of tumor as is often found in other types.

A noticeable and almost constant feature in this series was the manner in which the patients responded to different types of treatment. Those who were operated on and later died improved markedly until recurrent symptoms appeared after this the end came rapidly. Patients on whom palliative resection was performed had a similar postoperative course in most instances. Most of them who were sent home because of inoperable growths did not experience the symptom free period.

According to Balfour an important phase of the indications for resection is seen in the increasing frequency of the palliative resection which has a great advantage over gastroenterostomy in that the growth is removed obstruction is permanently relieved and the patient is assured of several months of comfortable existence.

The present combination of earlier diagnosis and better pre operative and postoperative management is making for higher operability rate lessened immediate postoperative mortality and better remote results.

The years covered in this study were divided into two periods of approximately 6 years each and the results of treatment in the first 3 years of each period compared. It was found that the number of patients with colloid carcinoma living 3 years or more was definitely increased and the number with other types of carcinoma markedly increased during the latter 6 year period. A study was made of the first and second periods in order to learn if there is a tendency for the lesions to be smaller as methods of diagnosis improve and patients perhaps are coming to physicians earlier. The results were convincing that during the last 6 years of the series the average size of the lesions was definitely smaller.

There is every reason to believe that cases of gastric carcinoma in which operation was

performed in the latter years in the series and those in which operation will be performed in the future will show results superior to the foregoing when enough time has elapsed for a comparison to be made

## SUMMARY

1 Colloid carcinoma occurred in about 5 per cent of gastric carcinomata. The percentage of patients living 3 and 5 years after operation is about the same as in these non colloid types of carcinoma. The incidence of late recurrence is greater in the colloid variety.

If there is involvement of the lymph nodes as a rule postoperative life expectancy is decreased.

3 Colloid on the grossa appears to increase the chances of postoperative longevity.

4 There is little tendency to fibrous tissue encapsulation in colloid carcinoma.

5 The postoperative mortality rate is about the same as in non colloid types of carcinoma. Postoperative life expectancy is less in young patients.

6 Colloid changes may be noted in the earliest stages of the carcinomatous process.

7 Exploratory operation and microscopic examination is the only sure way to make a definite diagnosis.

8 Resection of the growth usually gives a long symptom free period.

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SOME EXPERIENCES AND REFLECTIONS ON ONE THOUSAND  
LAPAROTOMIES FOR MYOMA OF THE UTERUS<sup>1</sup>

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THE history of the operations for fibroids is not yet one hundred years old in fact if the early tottering attempts were omitted and only the methodically and carefully prepared and executed operations were considered scarcely a generation has elapsed since the first operation. But what has not been accomplished during this time? As recently as 1872 Gailiard Thomas called the operation for myoma truly a formidable one today it is performed at every hospital with the same confidence and the same prospect of a favorable result as is any other abdominal operation.

Many pages have been written by Americans on the subject. Washington Atlee had the great satisfaction of seeing the first successful result after operation for myoma. Kimball of Lowell performed the first operation on a correct diagnosis. I should also mention the names of Emmet, Stimson and Kelly. We are right in saying of them as well as of all other pioneers who have preceded us. In what position would we be if they had not existed?

It is not my desire at this time to state that the technique of operation has been perfected nor do I wish to infer that my figures or my results should be regarded as especially noteworthy. I know very well that others have at their disposal more material and have secured just as good or better results. I would call attention however to that which still remains to be done. The advantages of the different methods of operation are not yet definitely settled, the primary results as well as the secondary might be further improved and radiology prompts us to reconsider the indications for operation. I also believe that a large number of cases from a given source offers better information for the discussion of certain points than would a series of cases collected from many different sources which would mean that different indications for operation are accepted and different tech-

niques followed. The amount of material is becoming so large that we hope eventually the factor of chance will be insignificant and that certain definite conclusions will be reached. Time permits me to touch upon only a few principal questions.

In one thousand of two thousand twelve cases of myoma observed during a given period operation was done that is in about 48 per cent. As is well known the percentage operated upon varies considerably with different gynecologists. Olshausen for example operated upon 16.1 per cent of his cases. Hofmeier 60.7 per cent and Engstrom about 100 per cent. This difference in percentages is based upon the fact that some operators regard the tumors and the operation as dangerous while others do not. Engstrom believed that enucleation was the fundamentally correct method of operation and that it was therefore advantageous to operate as early as possible.

But even with one operator the percentage of cases operated upon may vary. I find proofs of this in my own experience to begin with operation was done in 5 per cent of the cases, the percentage then dropped to 38.7. This was at the time radiological treatment was beginning to be used. The percentage again became higher and during the past few years it has reached the point of 63.9. As I mentioned previously the total percentage is therefore 48.1 i.e. operation is considered indicated in about half of the cases of myoma. Until the value of the X-ray in the treatment of myoma is definitely established it will be impossible to say whether this figure is exact and even then there will always be differences of opinion among different surgeons.

The indications for operation are clearly shown in Table I. In this table as well as in all the subsequent ones the absolute numbers can be made to indicate the percentages also if in each instance a decimal point is placed in front of the last figure.

TABLE I —INDICATIONS FOR OPERATION

Hæmorrhæ	494
Fibroid	159
Glycogenoma	19
Melancholic	8
Sarcoma	6
Carcinoma	1
Fibroid	2
Cystic degeneration	0
Tuberculosis	16
Subcutaneous malformation	4
Multinodular adenoma	4
Uterine adenoma	3
	1,000

It should be stated in regard to Table I that the figures are not the same as those which would be obtained if compiled from examination of the tumors after removal for example examination of slides showed that cystic degeneration was present three times oftener than was suspected before operation.

I will now take up the methods of operation which have been used (Table II)

TABLE II —METHODS OF OPERATION

Supravaginal amputation	0
Total extirpation	7
Partial	49
Leopold's method of total extirpation	35
	1,000

I will not discuss the latter group as the method of operation is familiar to all. However the relative value of the other groups is by no means as yet determined. That from a technical point of view supravaginal amputation is more easily performed than is total extirpation can hardly be disputed. Besides being more easily performed it can also be done more quietly which means that not only is it not necessary to keep the patient anesthetized so long and to use so large an amount of anæsthetic but of still greater importance the tissues in the pelvis are injured less.

Is this reasoning correct a difference in the results can be expected. The adherents to the principle of total extirpation look upon such a difference as unimportant and lay stress upon the fact that the results after total extirpation are improved each year so that the two methods are now on an equal footing.

Doederein gives a death rate of 5 per cent as an average for total extirpation and em-

phasizes the fact that this is a great improvement over the early death rate of about 9 per cent. This opinion may also be accepted but it seems to me to be just as indisputable that the death rate after supravaginal amputation is less in later years. My experience points in the same direction. The death rate after supravaginal amputation in my series of 199 cases is 2 per cent after total extirpation in 117 cases 6.9 per cent. It should also be remembered that total extirpation has been resorted to in more serious cases such as for tumors of the cervix and malignant tumors and the results therefore are not quite comparable with those for supravaginal amputation. If total extirpation had been used in the cases in which supravaginal amputation is now done it might be that there would be more similarity in results. At the present time however I cannot help but feel that the immediate safety of the patient is greater after supravaginal amputation than after total extirpation.

The question however is not completely answered by the primary results for we must consider the patient's subsequent state of health. An examination of my cases gives the following information. Of 14 patients upon whom total extirpation had been done 69—93 per cent—were in good health while 5—0.8 per cent—had some trouble. Of 496 patients upon whom supravaginal amputation had been done there were 91.3 per cent with out trouble and 8.7 per cent with trouble of some kind. The difference is slight and can be explained by the fact that exudation and hematomata which are sometimes observed after supravaginal amputation do not receive very easily after total extirpation which provides better drainage. This advantage however is counterbalanced by a certain unpleasant dryness in the vagina and introitus which does not appear after supravaginal amputation after which the discharge of mucus from the cervix is kept up. The figures I have quoted do not seem clearly to lend favor either to one or the other method.

In the presence of both a malignant tumor and a myoma it is evident that total extirpation is the operation of choice. Herbert Spencer is an energetic champion of total

extirpation as a standard operation in such cases. He reports his own cases as well as those of others in which the presence of the two conditions was overlooked or discovered too late.

It seems to me that this very question with which future research workers have to deal is at once the most important and the most problematic to solve. I do not enter here upon the question as to whether the myoma itself degenerates and becomes malignant or whether the two forms of tumor develop simultaneously with or without any etiological connection. The questions I would emphasize are: How often does the condition occur and is it possible to diagnose the presence of the two conditions before operation?

Since 1905 all myomata removed at operation have been examined histologically at the pathological institution through the courtesy of my colleagues Forssman and Sjovall. It is true that it has not been possible to make examinations systematically in the sense that all large tumors have been studied in serial section, but we have endeavored to examine especially carefully those which appeared suspicious to the trained pathological eye. If a few cases have escaped attention the final figures may be a little lower than they would have been if all cases had been examined. A tabulation of the findings from the examination of the myomata removed during a period of 10 years at one and the same place is shown in Table III. Curiously enough our figures coincide with those of Kelly, who in one thousand operations for myoma found both myoma and cancer twenty eight times. In the cases enumerated in Table III a diagnosis of malignant tumor has been histologically confirmed by competent pathologists. Cases in which a tumor was suspected on clinical examination but in which diagnosis was not microscopically confirmed are not included.

It should be added that at operation for some other condition and at postmortem examination myoma as well as malignant tumor was found in 1 case, 1 with sarcoma, 1 with adenosarcoma, 14 with cancer of the uterus, 4 with cancer of the ovary, and 1 with cancer of the vagina. As these cases do not belong

TABLE III—CASES OPERATED UPON DURING TWENTY YEARS

	C	%
Myoma plus sarcoma	18	
Myoma plus cancer of cervix	2	
Myoma plus cancer of uterus	5	
	25	
To the 6 may be added		
Myoma plus cancer of tubes	1	
Myoma plus cancer of ovaries	3	
Total	29	

to the one thousand in which operation has been done I wish only to mention them. My material should therefore indicate a frequency of 3 per cent for the significant complication. The figures from other places vary between 0 per cent (Pfannenstiel) and 10 per cent (Warnekros). This probably is not dependent upon mere chance but on the difficulty of discovering the presence for example of a sarcoma or a highly cellular myoma. However this may be the combination appears in a certain number of cases and thus the question arises. Is it possible for us to diagnose the condition before operation?

I regret to say that for my own part I must give a reserved answer. Just as simple as the diagnosis may be in some cases just so impossible does it seem in others. Curettement which might otherwise reveal the secret meets technical and other difficulties in a uterine cavity which has become distorted by the myoma. Should this difficulty not be present and it were possible thoroughly to curette the cavity not much relief is obtained as regards the sarcoma of the uterine wall.

The difficulties mentioned with regard to the diagnosis are further illustrated by the fact that in 19 of 29 cases the malignancy was not even suspected, far less diagnosed. In one of the cases in doing a supravaginal amputation the operator cut across a sarcoma which had infiltrated the cervix. I wish to emphasize again the great task which still remains to be solved through the study of the myoma problem.

It seems obvious to me that the choice between supravaginal amputation and total extirpation is dependent upon factors which cannot yet be definitely decided. Not until we have learned to diagnose before operation the simultaneous presence of a malignant



tumor and a myoma can we without hesitation do total extirpation as the treatment of choice in these cases. Possibly the use of supravaginal amputation in the future might be limited to the advantage of total extirpation. It may be added that I have not once observed carcinoma in the portio vaginalis after supravaginal amputation.

The conclusion I have reached with regard to the choice of method in operating is this: If in a patient before during or after the menopause a uterine tumor begins to change to increase in size rapidly to produce more abundant hemorrhage and to be painful and if the patient is losing flesh then malignancy ought to be suspected and total extirpation should be done. As a matter of course the degeneration may be of another kind but even then the tumor ought to be removed and total extirpation is safer.

Much has been written and said about the value of enucleation in the treatment of myoma so I will not repeat here all the arguments for and against it. Suffice to say that besides Martin other eminent gynecologists consider enucleation fundamentally superior. I need mention only the name of Otto Langstrom. In my own experience enucleation has been done 49 times without a fatality. There is thus nothing to be said as to the immediate results. The fundamental reasons for this method of treatment are not focused on immediate results but on the question of a later pregnancy and recurrence. The strength of the operation is to be found in the fact that pregnancy is possible. Its weakness is in the risk of recurrence. As to the possibility of pregnancy after enucleation, Engstrom states its frequency as 65 per cent. Winter on the contrary only 32 per cent. In my experience pregnancy followed enucleation in 6 cases that is in about 12 per cent—a figure of importance.

In contrast to this group of patients in whom enucleation has been done and thus the full function of the generative organs preserved is another group that is not fully satisfied namely those who have had a recurrence of hemorrhage or of a tumor. Martin claims that this condition is found in 6 to 7 per cent. Engstrom and Winter in 6 per

TABLE IV—PRIMARY MORTALITY

Puerperal mortality	1
Infant mortality	1
Primary mortality	1
Endometritis and pyometra	1
Endometritis and pyometra	1
Uterine infection (pyometra) of the bladder	1
Death at operation	1
Chloroform anesthesia	1
Miscellaneous deaths	1
Death in (a) patient	1
Death in (b) patient	1
Death in (c) patient	1
Death in (d) patient	1
Death in (e) patient	1
Death in (f) patient	1
Death in (g) patient	1
Death in (h) patient	1
Death in (i) patient	1
Death in (j) patient	1
Death in (k) patient	1
Death in (l) patient	1
Death in (m) patient	1
Death in (n) patient	1
Death in (o) patient	1
Death in (p) patient	1
Death in (q) patient	1
Death in (r) patient	1
Death in (s) patient	1
Death in (t) patient	1
Death in (u) patient	1
Death in (v) patient	1
Death in (w) patient	1
Death in (x) patient	1
Death in (y) patient	1
Death in (z) patient	1

cent. In my experience the number is higher—18 per cent. Such figures must of course be regarded as proof that the operation has been deficient in some respects and it must be so understood by the patient. Some patients have been obliged to be operated upon again and this was true in not less than 5 of my cases. Added to this the fact that of the patients operated upon radically a considerably larger number, 91 to 9 per cent are definitely in good health without any trouble while after enucleation several (in my series of cases about 3 per cent) complain of discomfort such as pain, menstrual disturbance and the like. It cannot be denied that this is often a drawback to an operation which is otherwise ideal in the sense that it removes the diseased part without sacrificing any of the healthy tissue.

In spite of the great respect that I have for the memory of Engstrom having been his pupil and in spite of the admiration I have for his contribution to this matter I do not however consider it possible to imitate him in giving enucleation the place of honor as the principal method. Even without such aspirations it has a place of honor among the operations for the treatment of myoma and cannot be replaced. In the course of time my own viewpoint has become such that I perform enucleation only if the patient is young for in time below 35 years of age and if in approaching marriage or other circumstances render the preservation of the power of conception specially desirable. I consider it a duty to the patient to explain the situation to her before the operation that she may decide a question that so clearly affects her future.

I next arrive at the question which interest all and especially the operator who reports

sible for the operation that is the question of primary mortality. In my material the primary mortality has been 4 per cent. I am quite aware that many in America are able to show better results. The causes of death are shown in Table IV.

Table IV is self explanatory so I will mention only the first two items. With regard to embolism the mortality amounts to 1.3 per cent a figure corresponding to that stated in other series. It would seem unfortunately that the causes of embolism would remain unknown for some length of time and that we would not be able to protect the patient against this danger. I have tried to promote the circulation of the blood and to counteract the want of exercise by means of massage performed by a competent person and started the day after operation. However I did not yet express an opinion as to its use as during this time there have been five cases of embolism in a series of 300 operations for myoma. The four cases of infection deserve mention as it would seem that with our up to date aseptic technique an infection ought scarcely to be met with.

An operative infection with a fatal termination has fortunately occurred only once. A real operative infection appeared in one case in which I have not the case history. The patient succumbed to paralytic ileus. In another patient the cause of death was an infection from a postoperative retroperitoneal hæmatoma. In a third case there was present a gangrenous myoma which resulted in an intraperitoneal abscess which was drained at operation. Autopsy showed septicæmia and also that by means of drainage the spreading of the infection into the peritoneum had been prevented. And finally the fourth case is of interest because the infection had originated from an intra uterine radium treatment later followed by operation with the result mentioned.

It may naturally be asked if any of these deaths might not have been avoided. As far as the cases with pulmonary embolism are concerned such an expectation is unfortunately not yet justified. As regards infection an operative infection may be so far avoided that it cannot exercise any great influence on

the result. On the contrary it is not possible to avoid an infection that arises from a tumor already infected or gangrenous and operation has to be done as a last resort. It must also be remembered that a university clinic in Sweden must receive cases which have been turned away from other clinics. Should we in such cases consider our statistics first or should we bear in mind the welfare of our patient?

As to the other causes of death two at least could have been avoided: the injury to the bladder which occurred in one of the earlier cases and the aspiration of vomitus. In the latter instance the patient vomited while alone and aspirated the contents. It should also be acknowledged that however careful we are or consider ourselves to be and however much the results are being improved with age and experience the day will surely never come when the results in a series of operations becomes such that improvement could not be made. To balance the risks correctly before interference is skill to say the least. *Es irrt der Mensch so lang er strebt*.

In a number of cases there have been other complications of consequence and yet the outcome has been favorable. We would mention thrombosis in 9 cases, pulmonary embolism in 4, parametritis or possible hæmatoma in 5 and parotitis in 2, as well as lesions in the ureters in 2. I will not dwell on these.

Other complications such as concurrent renal disease which have been diagnosed before operation are of great importance. Their nature is shown in Table V.

TABLE V

Ovarian or parovarian tumor	42
Malignant ovarian tumor	3
Hydroalpinx	3
Pyosalpinx	8
Tuberculo	10
Intra uterine gravidity	2
Tubal cancer	1
	69

The interesting point as far as treatment is concerned is that in more than 50 cases the complication was not diagnosed before operation and in most of these cases perhaps

30 there were certainly ovarian tumors present which were not discovered until operation. This has no other influence on the operation than that the adnexa are also removed. But the lack of knowledge as to the presence of adnexal disease may influence the decision of the surgeon as to the method of treatment to use—whether operation or the X ray.

Among other peculiarities in the cases of myoma operated upon I will mention only that in the last series of 300 cases of myoma myoma of the cervix appeared 7 times, a retroperitoneal myoma 9 times and a degenerated cyst 10 times.

I will not enter at this time into the question of pregnancy in the presence of a myoma as these cases in many respects and especially from an obstetrical point of view should be treated separately. I take the liberty only of contradicting the opinion that seems to prevail in certain publications in recent years that a myoma present in a pregnant woman should be removed for the reason that the growth may possibly give rise to complications during parturition. The morrow bringeth counsel: a myoma without any symptoms neither need nor should be operated upon during pregnancy.

There is still another matter of importance which I wish to mention. What will the result be if in removing a myoma both the ovaries are removed or one or both are left?

The question has been much debated and has had many different answers. It surely does not seem just to remove the ovaries unnecessarily in a young woman who is many years from the natural menopause. Again in another who has reached this period or is near it the risks seem less if the removal of the glands from technical or other reasons be advantageous. What are the real facts in the case?

I regret that I did not earlier pay the attention to this question that it no doubt deserves. I am not able therefore to make an exact statement except in reference to the last 300 cases. Of these 300 cases in 11 both ovaries were removed and I have definite information regarding them. It is remarkable to note that in 64 of these cases 84.4 per cent there was no trouble and 4 patients were less than

40 years of age. The 13 patients who had trouble that might be connected with the castration were all between 40 and 52 years of age. On the other hand I have report on 64 patients operated upon in whom one or both ovaries had been left and in whom there was no reason to expect endocrine disturbances. Of these 9—14 per cent—had symptoms of menopause. The ages in this group ranged from 1 to 43 years.

From these experiences it seems to me that two facts might be mentioned. First it is not easy to judge whether the symptoms really depend upon something else—a neurosis—a suggestion or whatever it may be—to which the operation has given rise or whether they might be the result of the removal of the uterus for why should such symptoms be observed in patients whose ovaries have been left? Second in a large number of patients the ovaries have been removed and no such symptoms have appeared and many times the patients are less than 40 years of age. I have therefore in the course of time come to the conclusion that the ovaries are not to be removed even in patients more than 40 years of age if menstruation still persists at the time of operation. On the other hand there need be no scruples against the removal of the ovaries if the adnexa show such change that the chances of the patient would be improved by ovariectomy.

I have touched in this paper only lightly upon a question which is full of such grave importance that it deserves thorough study; that is the question of the relative indication for treatment by operation and by X ray. The reason for this is that I have not yet had sufficient experience in this direction. I believe that one ought to wait until he has a large series of cases in which the X rays have been used and that such patients should be watched for many years before a definite statement is made as to which method of treatment is indicated—operative or radiological—in a given case. I shall restrict myself to the statement that I have tried the intra uterine application of radium to myoma in 103 cases but I have abandoned it entirely. In the case so treated a diminution in the size of the tumor was noted in 60

cases a favorable influence on hemorrhage in 87 cases but in 15 cases infection set in. For some reason or other 12 patients had to be operated upon later and 3 patients who were free from cancer before treatment were found to have it later. In late years I have cautiously and feelingly used the X ray treatment but the number is only 51 so far. The result of such treatment has been that immediately or after renewed treatment hemorrhage has ceased in 70—6 per cent—and that in 98 per cent operation has later had to be done. We should bear in mind in this connection the possibility of malignancy or other

degeneration being overlooked through faulty diagnosis.

Time will show to what extent X ray treatment is adapted to give the patient the same security as the operative treatment without subjecting her to the added risks. Should this be possible X ray treatment without any hesitation may replace the operative treatment should it not be possible I believe that an operation which removes the diseased part and leave the healthy is more to be desired than a method of treatment which by way of the ovaries influences the production of hemorrhages but leave the tumor.

## SUPPURATIVE DISEASES OF THE CHEST

By CEOPH I. MULLER, M.D., F.A.C.S., PHILADELPHIA

**S**UPPURATION within the chest would seem to be a comparatively simple matter to discuss and yet the uncertainty regarding certain phases and the technical difficulties involved in many of the procedures make it complex. As I have no new methods to offer and the recent literature is so full of productive work, I am forced to present to you the opinions of one who does general surgery with perhaps more than the average experience in chest surgery. Speaking as one surgeon to another we can exchange ideas regarding our own methods taken as they usually are from the more highly specialized studies of those engaged in a particular problem.

The great groups are empyema, lung abscess, bronchiectasis and mediastinitis. We must omit any preliminary discussion regarding the anatomy or the physiology of respiration, however tempting the latter may seem. Every surgeon who undertakes chest surgery should be familiar with the studies of Graham and the earlier writings of Garre, Sauerbruch, Willy Meyer, Lihenthal, Hedblom, to mention only a few which stand foremost in my mind. The section on pulmonary suppuration in the monograph of Garre and Quincke published in 1911 can be the starting point and upon this

base little by little one can build a knowledge of the shifts and changes which have had to occur before chest surgery attained its present sound position.

Empyema is the most important suppuration in the chest in the experience of most surgeons. As seen in ordinary civil practice it is practically always the result of a pneumonia. At this time we will not discuss whether it results from lymphatic or contact infection of the small serous effusion present in nearly all cases or whether it is due to the rupture of small abscesses on the periphery of the lung.

There are three matters of paramount importance. The first is to recognize the probability of empyema in every case of pneumonia that does not get well promptly. Delayed resolution is often another name for empyema. Prompt diagnosis is essential to low mortality and freedom from the chronic cavity. The second point is the need to distinguish between the synpneumonic and metapneumonic effusion. Operation should be delayed if possible until the pneumonia has resolved. There are statistics showing that the mortality approaches 50 per cent in a group of cases operated on during the first week after onset of the pneumonia, whereas it was 10 per cent between the fifth and eighth week. The latter

time is probably too long but certainly we should wait until the signs and symptoms indicate that the pus collection predominates and the pneumonitis has cleared.

The third point to be emphasized is the need for discrimination and individualization in the technical aspects. Ether anesthesia probably can be safely used in most cases but there is no need for it and certainly it is contraindicated in those who are sick. Local anesthesia and sometimes a little gas for adults is quite sufficient. Since the days of Hewitt (1876) and again since the War we have had periodic advocacy of drainage through a catheter as a standard method. I have practiced inter rib puncture in 34 per cent of my cases. But the experience of most surgeons is that open drainage is required sooner or later in most cases. In our series it was 77 per cent, 50 per cent of the children and 94 per cent of the adults requiring a rib resection after the preliminary intercostal tube drainage.

The point is this: we must not create an open pneumothorax while a pneumonia exists. If by reason of a streptococcus empyema as seen in the camps during the War or if because of great toxemia or pressure in the pneumococcal empyema we must operate during the synpneumonic stage it is imperative to do nothing more than relieve the pressure by the simplest means. But if the case has advanced to the metapneumonic phase with its walled off abscess and thick pus a rib resection with adequate drainage is indicated. Let me caution you not to delay too long if there is need for better drainage after a few weeks of intercostal tube drainage. The temperature reactions and the X-ray picture furnish the guides. As I am trying to deal with principles only, no discussion will be added regarding irrigation complications or after treatment. Early adequate dependent drainage is essential to success. It alone merely helps a little. Chronic empyema with cavity is an end result usually of delay and inadequate treatment. Before undertaking the serious and difficult operations for its cure we should study the writings of Keller and Hedblom.

Abscess of the lung is a more serious affection than empyema, not only from the stand-

point of treatment but also because of the greater difficulties in diagnosis. Some discussion of the etiological factors is essential. At least 50 per cent are postoperative in origin and about one half of these follow the operation of tonsillectomy. It is difficult to evaluate the exact mechanism concerned in the non-operated group. Lord (1935) believes that lobar pneumonia appears to be of little moment in the etiology and an origin in broncho pneumonia is uncertain. But some of the cases are so clear cut that it is probable that a small but definite group do follow lobar pneumonia. A larger group arise from the broncho pneumonias because of the greater damage to the lung. Most likely the lung in certain patients develops a low local area of resistance and secondary invasion of chance pyogenic organisms or of the various cocci, vibrios, spirochetæ and fusiform bacilli found in tonsillar crypts and around the teeth determines the breaking down of tissue. Smith (1937) has produced abscess by the injection of these organisms into the trachea and he noted that it is probable that abscess goes through a preliminary pneumonic stage before breaking down. Perhaps some of the apparent pneumonias described by patients with abscess are examples of this primary pneumonitis. Mulha (1926) offers some suggestive proof that paranasal sinus infection is capable of reaching the lung by way of the lymphatics. Foreign bodies of vegetal or other origin constitute a second group of suppurative diseases of the lung but this only simulates abscess and is more of a bronchiectasis because removal of the foreign body is almost invariably followed as shown by Jackson by complete recovery.

More interesting is the group which follows operations. Septic emboli from any focus discharging into the general circulation may cause acute abscess. When multiple the outlook is bad particularly as the patient is generally septic. Operations on the upper air passage, particularly tonsillectomy, is a cause for abscess. There have been a source of controversy now for several years. The great number of tonsil operations performed offers the probable explanation. The field is septic and the part in continued motion. Fetterolf and Fox (1933) brought this fact to our attention and since

then the work of Cutler and his associates have pretty well established the fact that most lung abscesses after tonsillectomy result from septic emboli just as do those after operations on other parts of the body. Smith however believes that his experiments prove the opposite and that aspiration is the potent factor. We must not exaggerate the frequency of abscess after tonsillectomy because an operator may do thousands of tonsil excisions before he has one abscess of the lung as a complication. Weil (1935) makes the interesting suggestion that when the patient never seems to convalesce has fever, constant cough and chest pain, then aspiration may be the cause whereas when normal recovery has occurred and suddenly about 10 days later the chest symptoms develop embolus is the factor.

The diagnosis of lung abscess is not particularly difficult if we pay strict attention to the history and character of the sputum in the case of a patient with cough, fever and chest pain. When suspicious we can get clear cut evidence from the roentgenograms if these are well taken because the casual roentgenologist rarely gets good pictures of the chest. Needling should never be used as a diagnostic aid because of the danger of producing pyothorax. The obscure cases are those small collections about the hilus and the interlobar collections which may be called loculated empyemata by some or abscess by others. If an expert bronchoscopist is available an additional aid to diagnosis is furnished. Nor need we be concerned as to the existence of abscess or gangrene. Most of the abscesses multilocular as they are have areas of gangrene in the walls and the massive gangrenes result from large infarction with death of the lung parenchyma before cavitation occurs. The symptoms of massive gangrene are so acute that there is hardly time for treatment before death occurs. Bronchiectasis is associated with most chronic abscesses but only becomes an entity when widespread throughout one or both lungs.

The treatment of lung abscess requires perfect localization, a nicety of judgment and careful technique. The internist, roentgenologist, surgeon and if possible the bronchoscopist should work together for the best

interest of the patient. The roentgenologist determines by the plain film and after lipiodol injections the exact location of the cavity, whether or not it drains and the extent of bronchiectasis. The bronchoscopist inspects the bronchial tree particularly for foreign body or tumor, notes the condition of the mucosa and whether pus is flowing from the lobes. He injects the lipiodol to outline the cavities and to diagnose the bronchiectasis; he also decides particularly in the case of lower lobe and hilus collections as to whether or not he can improve or possibly cure the patient by frequent bronchoscopic aspirations. The internist endeavors to improve the general condition of the patient, advises diets of high caloric value, administers asphenamine for the fever or gives creosote, arranges for blood transfusions in the very anemic and tries particularly by postural methods to effect drainage of the cavity.

We are all agreed that the desirable thing for the patient is to have the abscess drain into the bronchus. It is most unwise to operate during the more acute phases of the disease when the area of pneumonitis is extensive and the bronchioles are filled with pus. For both reasons non-operative methods always should be given a fair and extended trial but the method should be thorough and persistent. Perhaps 30 per cent will get well and stay well under rest, postural drainage and bronchoscopic aspiration. With Graham (1936) I am somewhat skeptical of the value of bronchoscopic aspiration alone, but Jackson and Tucker have had some very interesting cures in our hospital. Such treatment presupposes the probability of drainage and the X-ray and bronchoscopic examination determines this point. If drainage is not accomplished if the abscess is well up in the upper lobe or at the periphery then operation should be performed as soon as the patient's general condition has been improved. Sharp localization in the X-ray picture shows the subsidence of the pneumonitis. Even if drainage is accomplished the persistence of the cavity is an indication for operation. Furthermore I am of the opinion that with any degree of bronchiectasis external drainage of the cavity is advisable. I do not mean bronchiectasis of the lung but bronchiectasis of the lobe. Do not delay too

long and do not let your patient get away from treatment until cure is effected.

When operation is finally decided on many interesting technical points open up for discussion. In simple abscess I have found it best to resect a portion of one or two ribs over the area of abscess without opening the pleura. Some gauze saturated with mercurochrome solution is then packed against the parietal pleura and the skin flap temporarily closed. Four or five days later the wound is re-opened and it will be found that the lung is sufficiently adherent in practically every case so that the cavity can be entered with the cautery. The opening should be large and the cavity carefully drained and cleaned with the suction aspirator. If it is small I use only a large soft rubber tube but if large some mercurochrome gauze is lightly packed in for two days. All of the above procedures should be done strictly under local anesthesia. Shortly the cavity should be inspected for additional pockets and these and bronchiectatic openings can be opened up or treated with a small cautery point. This is the reason for making the external opening sufficiently large. I always keep the drainage tube in place for many months particularly if there is bronchiectasis otherwise flare ups will occur requiring re-opening of the incision. In some cases a limited thoracoplasty may be necessary. I do not believe that phrenic nerve section or crushing is worthwhile. No mention was made of artificial pneumothorax because I do not think it is a wise procedure. The exposure of the abscess is easy enough if it is perfectly localized except in the case of the upper and middle lobes high up and posterior. But the capsule can be winged by dividing the rhomboid muscle or the lower part of the scapula can be resected. In one female patient I was obliged to work well under the breast to expose a high anterior collection. I have entirely given up the older method of suturing the lung to the parietal pleura.

Bronchiectasis is the third suppuration in the chest. Usually some parenchymal inflammation such as an influenzal bronchopneumonia induces a fibrosis and thus twists and obstructs the bronchi causing their dilatation. When the dilated bronchi become the seat of a suppurative bronchitis purulent sputum

results which may be light periodic or continuous and excessively offensive. We must always remember the possibility of a local or other foreign body as an etiological factor. In some cases is infection from mildly epitheliomata may produce a suppurative pneumonitis with invasion of the walls of the bronchi, tubes and as Singer puts it a sort of carbuncular ulceration occur. These small pockets then appear to the roentgenologist as bronchiectatic areas. Atelectasis may be masked by shadow of the heart or diaphragm the fibrosis may be confusing or the pleura thick thus making X-ray diagnosis difficult. The injection of lipiodol has made such cases more apparent and has greatly enhanced our ability to diagnose bronchiectasis and determine its extent in a lobe, a lung or both lungs.

Surgical treatment of bronchiectasis has not yet attained a perfectly secure basis. It is conceded that the disease must be unilateral. Pneumothorax is not satisfactory. Intrathoracic lobectomy is too hazardous. Graham (1919) has offered a great improvement in his operation of cautery excision. A flap of the chest wall is turned up and 3 or 4 ribs removed for distances of about 4 inches. The exposed ends of the ribs are picked with bone wax to minimize the danger of osteomyelitis and the adjacent intercostal nerves injected with alcohol to destroy sensation in the wound. The pleura is then opened with a small incision and if firm adhesions are not present the cut is closed and the wound packed for a few days. Later at the second stage a large soldering iron heated to a red heat is pushed into the lung and the suppurative bronchiectatic area cauterized. It is essential to so cauterize as to obtain multiple drainage openings by exposing a large cross section of the bronchial tree. In about weeks cauterization is repeated. Hemorrhage is controlled by packing and this is efficient because the blood pressure in the pulmonary artery is usually only about 0 to 3 millimeter of mercury. Graham suggests that if ligation of a branch of the pulmonary artery to a lobe in the human being should prove to be as easy and simple an operation as Sauerbruch claims it to be then the danger of hemorrhage could practically be eliminated in the operation of

cautery pneumectomy by first performing a ligation of the corresponding branch of the pulmonary artery. If ligation of the corresponding pulmonary vein should also be performed then the danger of cerebral emboli would also be excluded.

Following the lead of Friedrich Sauerbruch and others Hedblom (1935) has advocated a graded extrapleural thoracoplasty for diffuse unilateral bronchiectasis. The whole lengths of the lower ribs usually from the third to the eleventh inclusive are resected in multiple stages the number of stages depending on the condition of the patient. While the diseased bronchi are not eradicated by the operation it has proved effective to the extent of markedly relieving cough and sputum in all cases approximating a cure in many. This operation is the only hope for patients in whom the disease involves more than one lobe of the lung. When the bronchiectasis involves the lower or perhaps the upper lobe alone it seemed feasible to amputate that lobe but in the hands of the average surgeon this operation has had a mortality approaching 100 per cent. Recently Whittemore (1937) has advocated delivery of the affected lobe outside the pleural cavity with anchorage by suture. In about 10 days the lobe becomes necrotic sloughs off and leaves a clean granulating stump deep in the pleural cavity with a bronchial fistula in it. The operation is similar to that proposed by Lockwood (1935) for abscess.

We must choose between these operations depending on the pathology. In diffuse unilateral bronchiectasis without abscess graded thoracoplasty seems obligatory. In lobar bronchiectasis and this is usually complicated by abscess extrathoracic excision of the lobe may be considered if there are no adhesions. In the presence of adhesions and multiple abscesses the cautery method of Graham seems best. The objections to thoracoplasty as leaving infected bronchial tissue are met by the statement that secondary cautery operation is feasible. Hemorrhage following cauterization is to be feared but usually is controllable with gauze picking. The occurrence of cerebral embolus is not confined to the cautery operation. I have lost two patients

after simple drainage from this cause when recovery from the abscess had practically resulted.

Suppurative mediastinitis is the last of the group under consideration which I will discuss. The sources of mediastinal suppuration may be traced to the adjacent bones, the lymph nodes as an extension from the neck especially after operations in the lower part which are followed by suppuration or as part of the suppuration of streptococcal empyema. I have had deaths from this cause after an operation for intrathoracic goiter after a ophiotomy and after block dissection of the neck for cancer. The symptoms are grouped under the head of pain, sepsis and pressure on structures in the mediastinum. When recognized the abscess should be opened and drained. This is easy of performance in the case of the anterior mediastinitis but in the case of posterior mediastinitis one must choose between cervical mediastinotomy and the dorsal approach preferably by the method of Heidenhain. The latter certainly gives better drainage but is harder to perform.

Even from this rapid review one can become enthusiastic about thoracic surgery. The problems seem more complicated than those met in the abdomen but this only makes the subject more fascinating. Rather recently a new field is opening by reason of the development of a method of thoracoplasty for the cure of certain cases of pulmonary tuberculosis but the treatment of tumors of the lung still awaits solution. It will not be long before the surgery of the thorax attains the same sound position that is occupied by the surgery of the abdomen and cranial cavity and this will lead to greater refinement in technique, lower mortality and better end results.

#### DISCUSSION

DR C. A. HEDBLOM, CHICAGO: Dr Muller's presentation seems to me remarkably comprehensive, concise and detailed considering that his theme embraces the major portion of the whole field of thoracic surgery. With most of Dr Muller's postulates I am in entire accord. To one or two of them I should like to add what emphasis I may. To some particulars in which I disagree I shall devote most of the limited time at my disposal.

In his discussion on empyema Dr Muller very properly emphasizes the importance of early diag-





## THE RELATIONSHIP OF CARCINOMA AND CALLOUS GASTRIC ULCER

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WHEN Cruveilhier first distinguished gastric ulcer from carcinoma he mentioned their occasional coexistence in the same stomach. For 50 years they were thought to have little or no connection with each other. Then Zenker made the suggestion that gastric carcinoma might arise regularly from a preceding ulcer and in 1883 his pupil Hauser (47) published a careful pathological report illustrating this method of development. Just before the publication of this study of postmortem specimens however had begun the brilliant advances in gastric surgery which were soon to vitalize the question of a relationship between carcinoma and chronic gastric ulcer. Billroth reported the first successful resection of the pylorus for carcinoma and Woelfler introduced gastroenterostomy in the same year 1881. Gradually surgeons learned that a number of cases following gastroenterostomy for an indurated gastric ulcer died later of carcinoma of the stomach (Rodman 70 and Mayo 59). Furthermore in specimens of resected stomachs on microscopic examination carcinoma was found in many cases where the history and operative findings had led the surgeon to make the diagnosis of benign chronic ulcer. This frequent association of the clinical syndrome or the gross picture of chronic gastric ulcer with histological cancer stimulated several surgeons and some pathologists to urge the frequency of carcinoma ex ulcere.

This idea was for a time received favorably. It is true that a Lyons group headed by Tripiet and Duplant described a variety of gastric carcinoma characterized by extremely slow growth, chronic ulceration and clinical symptoms mimicking chronic gastric ulcer (80 and 31). This type they named *ulcus rodens gastrique*. They felt that the lesions showing both carcinoma and ulcer were ulcerated primary cancers rather than the carcinomatous degeneration of a benign ulcer. But the demonstration of a chronic gastric ulcer in

the walls of which carcinoma cells were found was frequently advanced as adequate proof of carcinoma ex ulcere. And some went so far as to assume that gastric cancer usually arose upon an ulcer basis.

However by a critical pathological study of the benign and carcinomatous ulcers the following points were gradually established: (1) Localized infiltrating carcinomata often become ulcerated. (2) Such lesions have the typical gross appearance of a chronic gastric ulcer. (3) In certain areas all of the malignant cells may disappear. (4) Usually when cancer cells are found in ulcers they are distributed in different parts of the latter which is evidence in favor of primary ulcerated cancer rather than a carcinoma developing in one part of a chronic ulcer. (5) The scar tissue base of the chronic ulcer entirely replaces the muscle layer while the carcinoma cells in ulcer like lesions usually infiltrate between some preserved muscle bundles. (6) In order to demonstrate the probable development of carcinoma from an ulcer it is necessary to find such a scar tissue base not infiltrated with carcinoma (Stewart 73 and Spilbury 74).

Applying such criteria for a pre-existent ulcer to a study of the specimens showing carcinoma, Aschoff (4) and Stromeyer (76) concluded that there was evidence of the malignant degeneration of chronic gastric ulcer only in a small percentage. Dible in a very critical pathological study has recently confirmed this opinion (26). From such investigation we may conclude that carcinoma of the stomach does not usually arise from a preceding chronic ulcer. If the application of the critical pathological studies stopped here it would have served to critically reject the unsupported hypothesis. But from the apparently obvious corollary has been deduced by several that the danger of carcinoma need rarely be considered in the diagnosis and treatment of chronic ulcers. This point of view was recently



I Ca e C n ma s mple the ba f th  
ulc (X4)



Fig Ca r S me ctio as I re (X12)

for example by Morley in the symposium of the British Medical Association on carcinoma of the stomach (6). After quoting Dible's pathological studies he concludes:

An event of such comparative rarity (the malignant degeneration of chronic gastric ulcer) should not influence us then unduly either in the diagnosis of gastric carcinoma or in the treatment of gastric ulcer. This same sense of security is expressed even more forcefully by the action of many physicians in instituting a protracted dietary treatment in cases that clinically appear to be chronic gastric ulcer.

There have grown up then two diametrically opposed points of view in regard to the relationship of carcinoma to callous ulcer in the stomach. Cabot and Adie have recently summarized this protracted discussion (15). The issues debated have been the occurrence and frequency of the development of gastric carcinoma from gastric ulcer. This controversy over the pathological mechanism has tended to obscure rather than to emphasize certain facts of fundamental clinical impor-

tance. In the treatment of every case diagnosed as chronic gastric ulcer the question that must first be answered is: What danger is there that this condition may now or later be malignant?

Two patients who were in the Peter Bent Brigham Hospital at the same time illustrate the clinical importance of this problem. Similar examples could as easily be taken from the experience of all physicians and surgeons who follow up the end results on their cases diagnosed as chronic gastric ulcer.

CASE 1: J. M. S. P. B. H. Surg. No. 20006, male, aged 58, admitted October 31, 1933, with the complaint of vomiting. The present illness began 5 years previously with epigastric distress after meals, which had increased in severity. There was relief by food and soda and the discomfort was accentuated by dietary indiscretion. Two years previously periodic vomiting had begun occurring every 3 or 4 weeks at first but the last year coming about every 10 days. The vomitus never contained fresh or old blood. For 9 weeks he had been on a milk diet which had relieved the epigastric distress but had not prevented the periodic vomiting. Appetite had been excellent and he had had acute hunger on the milk diet. He had had no tarry stool except on one occasion immediately after the extraction of all his remaining teeth. He had always had a tendency to constipation which had been greatly accentuated in the last year. He had lost only 10 to 15 pounds with the reduced diet and vomiting and had continued to work throughout.



Fig 3 Case 2 Adenocarcinoma in callous ulcer by note infiltration of carcinoma acini between muscle bundles (X40)

The past history is irrelevant. Physical examination demonstrated moderate loss of weight. The heart had a systolic murmur well transmitted. The abdomen was scaphoid, soft and contained no masses. The liver was not enlarged.

Leucocytes 17,000, hemoglobin 90 percent. Urine negative. On account of the vomiting gastric analysis was not done, but the vomitus showed an excess of free hydrochloric acid and a negative benzidine test.

X-ray examination revealed a dilated atonic stomach of smooth outline everywhere except at the pylorus where there was a concentric narrowing involving the sphincter. There was irregular and reverse peristalsis in the stomach and nearly complete 6 hour retention. The interpretation was obstructive lesion at the pylorus which may be either carcinoma or ulcer.

The consensus of opinion before operation was that the lesion was a cicatrizing gastric ulcer with pyloric stenosis, though the possibility that it might prove to be a carcinoma could not be excluded. Dr. Cheever's note of November 4 states: "The picture is a characteristic one of benign pyloric stenosis due to cicatrizing ulcer and I think that probably a Finney pyloroplasty will be the best treatment."

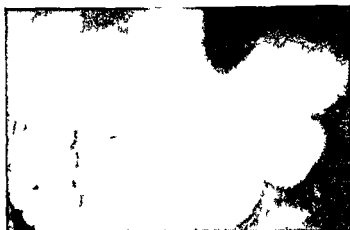


Fig 4 Case 3 X-ray of the stomach Niche on lesser curvature

At operation November 5, 1923 (by Dr. Cheever and Scott) before the Boston Surgical Society, a small ulcer of the lesser curvature was found. It was surrounded by extensive induration which reached nearly to the pylorus (5 centimeters) but did not occlude this orifice. The induration suggested malignancy and partial gastrectomy (Billroth II) was performed. Also a small nodule 3 millimeters in diameter on the anterior surface of the duodenum, 1 inch past the pylorus was removed. Frozen sections were made particularly on account of this anomalous nodule on the duodenum. The pathologist reported on the frozen section that the gastric ulcer was benign but that the nodule from the duodenum was an adenocarcinoma. However, when the fixed sections were obtained the pathological report was revised. The nodule of the duodenum was an aberrant pancreatic nodule and the gastric ulcer showed definite carcinomatous infiltration in the base (Figs. 1 and 2). No metastases were found in the glands.

The patient had an uneventful convalescence and was discharged November 2, 1923. He had gained 20 pounds and was feeling perfectly well in June, 1925. Since then it has been impossible to obtain any information concerning him.

CASE H. E. L. PBBH Surg No. 0179 female aged 65 years admitted November 23, 1923 on account of epigastric distress, anorexia and vomiting. For the past 30 years she had had periodic attacks of epigastric distress after meals, relieved by soda, by induced vomiting and sometimes by food. No hematemesis. The attacks were more frequent in the last 2 years. For the past 6 weeks anorexia and vomiting have been marked. Vomitus contained food taken 24 to 48 hours previously. The past history is irrelevant.

Physical examination showed no cachexia and only slight loss of weight. The abdomen contained no masses but there was peristalsis seen in the epigastrium.

X-ray studies showed an atonic dilated stomach with vigorous irregular peristaltic waves. The outline was smooth except in the antrum where the



FIG 6

Fig. 6 (X 5) 1 1 1 1

outline of both curatures a regular. There was 75 per cent duodenal ulcer. The X-ray findings were interpreted as suggesting a carcinoma of the antrum with partial obstruction.

Gastric analysis: test meal free hydrochloric acid 0 per cent total acidity 70 per cent. Urine negative. Blood hemoglobin 106 per cent. Erythrocytes 5,480,000; leukocytes 7,600; polymorphonuclear 53 per cent; lymphocytes 41 per cent; mononuclear 6 per cent.

On account of characteristic ulcer history of 30 years' duration with hyperacidity and absence of cachexia the preoperative diagnosis is a chronic gastric ulcer although the X-ray findings rather favored carcinoma but were not compatible with ulcer.

At operation November 4, 1933 (by Dr. Holm), a colloid ulcer in the lesser curvature close to a dividing tendon of the pylorus was found. It was thought that this was a benign ulcer; the operative note stating: "However the amount of induration present and the adhesion on the upper surface prompted the operator to perform a pylorotomy in test of a 1 1/2 inch pyloroplasty." (A. J. Ochs, Baltimore, personal communication.)

The gross specimen showed a penetrating ulcer on the lesser curvature near the pylorus with a crater 1 centimeter in diameter surrounded by considerable induration. The gross appearance suggested a cicatricial ulcer. Sections from the edge showed only chronic inflammatory reaction. Section from the base of the ulcer showed carcinoma cells infiltrating the muscular layer and permeating between the muscle bundles (Fig. 3).

The patient's convalescence was uncomplicated and she was discharged December 14, 1933. On November 24, 1936, she was symptomatic and gastro-intestinal X-ray examination showed no evidence of recurrence. In response to a letter in March, 1937, she responded that she had had no indigestion and that she was well and strong.

These two cases from their clinical story and laparotomy findings suggested callous gastric ulcers which had caused pyloric obstruction. At operation one of the lesions seemed to the operator to be benign; the other one was thought probably malignant but on frozen section a pathological report of benign chronic gastric ulcer was given to the operator in the latter case. Fixed sections in both instances showed infiltration of carcinoma in the scar tissue base. Consequently on the basis of the pathological evidence these cases are not to be classified as carcinoma ex ulcer. They probably are examples of a slow growing primary scirrhous carcinoma of the stomach in which ulceration proceeded almost concurrently with the proliferative process. It seems almost certain that the second case had some preceding condition other than carcinoma to produce ulcer-like symptoms for 30 years as there was nothing found at operation outside of the stomach to account for such symptoms. Possibly this lesion was a chronic gastritis as suggested by Vere (81) and Mathieu (58). These cases would not even be included in the group studied pathologically by Dible because in each case some phase either in the clinical picture, the findings at operation, or the gross appearance of the lesion suggested to the surgeon or the pathologist the possibility of carcinoma. The significant facts clinically are that such cases as these quoted are frequent occurrences that they either begin upon or probably more often only mimic an indurated ulcer but that these two conditions cannot be certainly differentiated by any known clinical method. On account of the ulcer-like symptoms such carcinomata are usually diagnosed as ulcers.

Such cases proving pathologically to be localized ulcerated infiltrating carcinoma but diagnosed clinically as ulcer are frequent. Instances in which there is histological evidence of a pre-existent chronic ulcer are very

much rarer. The following case seems to belong in this latter small group.

CASE 3 C H B S M H No 4368 male aged 66 admitted December 11, 1916 with the complaint of pain in the stomach. The present illness began 1 year ago with epigastric pain coming on 3 hours after meals and always relieved by food and soda. With periods of remission it has bothered him since onset. In the last months the pain has been exactly as previously except that it has come about 4 hours after meals. Seldom has he vomited and never had hæmatemesis or melena. He has had no loss in weight. Wassermann reaction has been strongly positive and he has had energetic anti-luetic treatment for over a year. X-ray showed a penetrating ulcer niche on the lesser curvature with vigorous peristalsis elsewhere (Fig. 4). No 6 hour residue.

Blood hæmoglobin 80 per cent urine negative stool formed brown microscopically no red blood cells guaiac test negative. Gastric analysis fasting free hydrochloric acid 18 per cent total acidity 46 per cent. After 1 hour meal 45 minutes free hydrochloric acid 18 per cent total acidity 43 per cent 75 minutes free hydrochloric acid 5 per cent total 76 per cent.

The pre-operative diagnosis was callous gastric ulcer there was no positive indication of malignancy.

At operation on December 18, 1916 (by Dr. Scott) a penetrating ulcer with a crater about 1.5 centimeters in diameter and 1 centimeter deep was found. There was nothing to suggest malignancy. The base of the ulcer was adherent to the pancreas. Partial gastrectomy (Ilya Moynihan) was performed and the area where the ulcer was attached to the pancreas was cauterized. Convalescence was uncomplicated and the patient was discharged January 15, 1917. He has gained 15 pounds and has remained symptom free to the present (May 1917).

The gross specimen showed a typical callous ulcer with no suggestion of malignancy. The edges were firm but not abnormally indurated. The proximal edge was overhanging and the distal one was terraced.

On section the base of the ulcer was formed of scar tissue which entirely replaced the musculature and showed merely the usual evidence of chronic inflammation (see characteristics of chronic ulcer Fig. 7). In one area however there was a definite small zone of adenocarcinoma which spread out from the hyperplastic mucous membrane at the edge of the ulcer (Figs. 5 and 6). This did not infiltrate the scar tissue base at a distance. In other sections carcinoma was not found. After the discovery of this one area of definite carcinoma 8 blocks were cut from various areas of the uncut half of the ulcer. In none of them was there any trace of carcinoma (Fig. 7). It was felt therefore that the specimen fulfilled the exacting pathological criteria of a carcinoma arising presumably upon a pre-existent ulcer.



Fig. 6 Higher magnification of section outlined in Figure 5 showing a cluster of carcinoma acini ( $\times 50$ )

Although we feel that this is an illustration of *carcinoma ex ulcere* its clinical significance is the same as if carcinoma cells had appeared in multiple places in the ulcer. Its chief interest lies in the fact that it appeared clinically to be an uncomplicated case of chronic gastric ulcer both before and at operation yet it proved to be carcinomatous.

The history was a typical ulcer story of 12 years duration. The gross appearance of the ulcer gave no suggestion of malignancy. In fact it appeared so evidently benign that no photograph of the gross specimen was made. Without the histological findings or if the first sections had been cut only from the half of the ulcer which by chance was cut later after finding the isolated carcinoma focus no one would have thought it anything but a typical callous gastric ulcer which had penetrated sufficiently deeply to become adherent to the pancreas.

INCIDENCE OF CARCINOMA IN CALLOUS  
ULCER

The clinical importance then of the relationship of carcinoma and chronic gastric ulcer is not dependent upon the development of the former from the latter but lies in the impossibility of the certain clinical differentiation of the two conditions. This difficulty is not reflected in the hospital record. When malignancy has been found in the resected specimen carcinoma of the stomach appears as the final diagnosis and the diagnostic problem is buried in an analysis of cases under the heading of carcinoma of the stomach with a positive ulcer history. Before operation though the case is a chronic gastric ulcer and when the microscope does not reveal the mistake it often remains on the records as only a chronic ulcer the patient dying elsewhere of carcinoma. It is extremely difficult to disentangle from a statistical presentation of cases the data that will present in a true light this clinical dilemma of the differentiation of benign callous ulcer and ulcer carcinoma.

The reports based upon cases only diagnosed clinically and not operated upon have limited value on account of (1) the difficulty in being certain that an ulcer is present (2) the confusion of duodenal and gastric ulcers and (3) the difficulty in determining the final outcome. I have found no report of a series of cases with convincing X-ray evidence of gastric ulcer followed over a sufficiently long period of time (at least 5 years) from which to derive data as to the proportion of chronic gastric ulcer cases that eventually prove to be carcinomatous.

Nielson's study of the end results of medically treated cases clinically ulcer describes mention although X-ray evidence is largely lacking (63). His selection of cases included only those in which there was good evidence of organic disease though a large proportion of them must have been duodenal rather than gastric ulcers. Of 111 died of gastric carcinoma and 1 other had carcinoma in the part of the stomach resected later. Thus of the total series 5.4 per cent were subsequently proven to have carcinoma of the stomach. This would probably correspond to about 20

per cent of the true gastric lesions as duodenal ulcers are at least 4 times as numerous as gastric in the clinics. All but 2 of the cases developing carcinoma had had symptom for less than 6 years (15 per cent of the 66 cases of chronic ulcer with such a limited duration of symptoms).

This study of medically treated ulcer although unsatisfactory for statistical analysis on account of the lack of X-ray evidence still definitely demonstrates again the danger of carcinoma proving to be present in cases clinically diagnosed as benign ulcer. Johnson (49) also reports 7.6 per cent mortality from carcinoma in the combined series of gastric and duodenal ulcer.

Suppy (71) emphasize the necessity of watching for the evidence of a carcinoma as a possible complication in all case of gastric ulcer but he gives no statistical figure. Smithie (73) emphasize that many authors denying the danger of carcinoma in gastric ulcer are dealing chiefly with duodenal rather than with gastric ulcers and he adds that he always feels nervous about the outcome of a true gastric ulcer until a laparotomy has determined the location and nature of the lesion. His deficiency in regard to exact reports of the final result of medically treated gastric ulcer in part is due to the fact the X-ray localization has only been of great help in the last 15 years and in part because internists have come to realize increasingly that the medical treatment of true callous gastric ulcer is unsatisfactory and dangerous (Alvarez 1).

Although more exact statistical reports of the evidence of carcinoma in medically treated chronic gastric ulcer are lacking its danger is amply attested by the large number of lesions diagnosed as benign ulcer after careful clinical study that prove upon operation to be carcinomatous. In the examination of resected callous ulcers clinically benign carcinoma was found in the following per cent: Moynihan (64) 18 per cent, Payr (65) 6 per cent, Kuettner (50) 0 per cent, Finsterlin (58) 21 per cent, von Haberer (43) described the diagnostic difficulty at operation after exposing the lesion as follows: Five per cent mistakes how many doubts! Morley

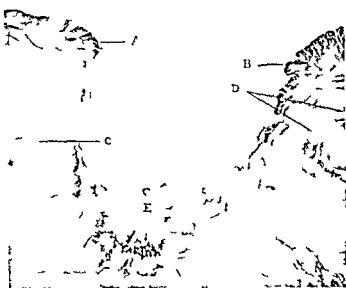


FIG. 3 Case 3 Typical chronic indurated ulcer Note overhang in edge A somewhat terraced edge B muscle completely interrupted C and D and inflammatory scar tissue base E (X15)



FIG. 4 Case 4 Photomicrograph of a colloid carcinoma from the base of a callous ulcer Note the presence of acini infiltration between the muscle bundles (X125)

although willing to dismiss the danger of carcinoma from consideration in the treatment of gastric ulcer received a pathological diagnosis of definite carcinoma in 10 per cent of 50 specimens considered by him even after they had been removed to be simple gastric ulcers (61) Aschoff who is extensively quoted as an opponent of the frequency of carcinoma ex ulcere expressed surprise at the large number of resected specimens resembling in form the ordinary round ulcer but proving microscopically to be carcinomatous (4) Masson (56) reported that in 1400 resected ulcers clinically benign 15 per cent were found to be carcinomatous on histological examination. From these statistics of many clinics it would seem to be a conservative estimate that in 10 to 20 per cent of the chronic gastric ulcers there is a carcinoma actually present whether it has arisen from a chronic ulcer or has been from the first a primary carcinoma with secondary ulceration.

Another line of evidence corroborates this significant proportion of indurated ulcers that appear benign but prove malignant. An actuarial study of the life expectancy of patients operated on for duodenal and gastric ulcer at the Mayo Clinic was made (6 and 8) The death rate in the succeeding years was not above the normal expectancy after operations for duodenal ulcer but was over 3 times

this figure after operations for gastric ulcer (17 per cent mortality in 5 1/2 years) The most important factor causing this was the development of gastric cancer. In 180 patients followed for an average of 3.6 years after operation for gastric ulcer there were 195 deaths at least 75 of which were determined as due to carcinoma and many more in which the data was inconclusive probably died of this cause. Upon a careful re-examination of the specimens classified as ulcer at operation from patients dying subsequently of gastric carcinoma it was found that half of them showed evidences of malignancy that had been overlooked (Balfour 8) Also Anschuetz (2) reports death from gastric carcinoma in 8 to 11 per cent of cases of calloused ulcer followed years or more and in 334 gastro-enterostomy for ulcer of the stomach and duodenum von Eiselsberg (33) found that in 41 remote deaths 13 were known to have been due to carcinoma of the stomach a probable incidence of 15 to 20 per cent in the true gastric ulcers. It is quite impossible certainly to differentiate benign calloused ulcer from carcinoma at operation sometimes after examination of the resected specimen and occasionally even histological study of the ulcer does not settle the question. Eggleston (32) Wilensky and Thalheimer (85) Mayo (60)



## DISCUSSION OF STATISTICAL RESULTS

There are many reports based upon more or less carefully analyzed clinical material in which the conclusion is reached that carcinoma is an infrequent finding in gastric ulcer. Opposed to this view is the opinion from many surgical clinics that carcinoma is a very frequent finding in callous gastric ulcer. This apparent contradiction in some instances of each opinion due merely to careless diagnosis either clinical or pathological. But even in the most carefully studied cases the same difference of opinion is recorded. This is more apparent than real however. In the medical series are usually included those cases that have symptoms suggestive of ulcer many of short duration and most of which are not verified by demonstration of the lesion. The surgical group is made up almost entirely now of indurated ulcers of long standing. By operation the existence and the character of the lesion have been demonstrated. A careful pathological study of such resected specimens has entirely changed our opinions concerning the life cycle and the degenerative and regenerative processes of chronic gastric ulcers. Crohn Weiskopf and Aschner (20). The apparently opposing views are consequently dependent largely upon the types of cases studied and often from the data included in reports of non operated cases it is extremely difficult to be certain what varieties of ulcer the author is reporting. It is generally accepted now that acute or subacute gastric erosions frequently heal and remain healed under proper medical treatment that consequently such lesions should not be operated upon except for their complications and that they are not precursors of carcinoma. Crohn Weiskopf and Aschner (21). Such acute ulcer syndromes are much more common than the chronic indurated ulcer. Moynihan (64). On account of their inclusion as well as that of other lesions that are not chronic gastric ulcers (especially chronic duodenal ulcer) in the group of medically treated patients the danger of carcinoma in true callous ulcers is sometimes hidden in the reporting of such lesions. Especially is this true if both gastric and duodenal ulcer are included in one study under the designation

peptic ulcer a term which of itself signifies a lack of sufficiently exact data for accurate localization. For properly evaluating the dangers and the results of treatment in the much less frequent chronic gastric ulcer these should always be presented in a separate group distinct from acute gastric ulcer and from duodenal ulcers. In order to clarify the diagnosis and the type of lesion in future analyses of cases it would be of great assistance if gastric ulcers were classified somewhat as Cushing (2) has grouped brain tumors.

## CLASSIFICATION

For use both in the hospital record and in the reporting of cases of gastric ulcer I propose the following classification.

- I Gastric ulcer—suspect
- II Gastric ulcer unverified (carcinoma suspect)
- III Gastric ulcer verified
- IV Carcinomatous gastric ulcer verified

Under each of the first 3 headings designate whether acute (non indurated) or chronic (indurated).

*Gastric ulcer suspect* include all cases in which a tentative diagnosis of gastric ulcer is made. In the localizing evidence to distinguish between gastric and duodenal lesion is often lacking and so the 2 groups may be classed together as peptic ulcer suspect if so desired. It is only in this group however that the non localizing term peptic should be permitted. Many in this group prove later to have no ulcer at all but to have ulcer mimicking symptoms from pylorospasm gall bladder disease etc. The peptic ulcer suspect cases should not be included in a consideration of gastric or duodenal ulcer except as regards the differential diagnosis. Moynihan (63) has emphasized the great importance of basing the study of gastric ulcer upon the case proved by X-ray or operation to have an ulcer.

*Chronic gastric ulcer verified* includes those cases that have definite signs of localization in the stomach as well as ulcer symptoms sufficient to establish the diagnosis clinically. Specifically the clinical picture should be supported by X-ray or operative evidence compatible with indurated gastric

ulcer These lesions are always carcinoma suspects

*Chronic gastric ulcer* *crified* includes only the cases having histological evidence of an indurated ulcer If carcinoma is found in the ulcer it places the lesion in the class of proven gastric carcinoma but in order to have the ulcer like malignant lesions available for study it would be advisable to name them

Carcinomatous gastric ulcer and cross file them both under carcinoma and under chronic gastric ulcer

It is now at once evident that most of the gastric erosions the acute gastric ulcers must necessarily fall in the group of gastric ulcer suspects as usually there is not sufficient localizing data to justify the diagnosis of gastric ulcer unverified Very rarely can they be classed as acute gastric ulcer verified since most of them disappear under medical treatment In the earlier days of gastric surgery operation was frequently performed for such ulcers without finding any definite lesion

If the cases are reported under such a classification it at once forms a basis for comparison and analysis such as does not now exist in many of the reports of gastric ulcer I believe it will quickly dispel the appearance of disagreement in regard to the danger of carcinoma occurring in cases diagnosed clinically as callous ulcer of the stomach

Including only the cases having had ulcer symptoms for several months and showing X-ray evidence of a gastric lesion compatible with ulcer 10 to 20 per cent of such chronic gastric ulcers unverified, will prove to be carcinomatous

#### TREATMENT AND RESULTS

As a direct and specific corollary of this fact all cases of chronic gastric ulcer ought to be considered and treated as carcinoma suspects Nearly all writers agree that a suspicion of malignancy is an urgent indication for radical surgical treatment of a chronic gastric ulcer (Alvarez 1 Bevan 10) From the cases and evidence cited above it seems that the symptoms of chronic gastric ulcer constitute such a suspicion of malignancy and consequently except for positive contraindications to operation the lesion should prompt-

ly be removed (Douglas 28 Finsterer 36) Lahey (51) advises the hospitalization and medical treatment of such cases for weeks At the end of that time he decides upon the basis of relief of symptoms, the absence of occult blood and decrease in the size of the X-ray niche whether the lesion is benign If these criteria are not favorably affected he operates This is a big improvement over the previous method often used of ignoring the danger of carcinoma or of heeding it only when positive clinical signs of malignancy have developed When an ulcer shows such a change in symptoms with constant pain emaciation and an acidity it usually means the extension of the malignant process so that the chance for surgical cure usually is already gone (Cheever 18 Cheney 19 Masson 56) Even the method advocated by Lahey however does not with certainty differentiate malignant from benign lesions in the early stages A carcinomatous ulcer may for a time show partial healing great improvement in symptoms and absence of occult blood (Dieulafoy 7 Hurst 48 Eusterman 34) Consequently it seems to me to be the wisest course to regard all callous gastric ulcers (as defined above) as potential cancers One of our prominent gastro-enterologists emphasizes this point thus If the physician lets him (the patient with chronic gastric ulcer) drift on with medical treatment he assumes a tremendous responsibility (Alvarez 1) If this point of view can be inculcated into both the profession and the laity the outlook would be greatly improved in this ulcer mimetic group which constitutes about one fifth of the gastric carcinomata and we should have made a stride forward in the percentage of curability in this form of carcinoma Twenty years ago carcinoma of the stomach was regarded as having practically a hopeless prognosis (Friedenwald 40) Today there are a number of 15 and 20 year cures so that we are certain that the prognosis is not hopeless (Wegele 62 Bisch 9) and in cases that can be resected there is 22 to 31 per cent 5 year freedom of recurrence (Anschuetz 3 Finsterer 37 Hartmann 45) Our immediate hope of improving the results in gastric cancer lies in operation while complete removal of the

malignant process can be carried out (Cheever 17). There are definite lines of progress toward this end which have in common the treatment of patients above the age of 35 with gastric complaints as carcinoma suspects unless the latter can be ruled out (Blackford 11). In one group are those that in middle life or later without any obvious cause develop some vague gastric symptoms or general asthenia and loss of weight (Goldie 41, Master 57). Such cases are to be carefully investigated as possibly having carcinoma of the stomach and if necessary for its exclusion an exploratory laparotomy should be performed (Deaver 5, Dunham 30). The other group is that of the indurated gastric ulcers. These cases can never be differentiated clinically as certainly benign (Smithies 7). X-ray examination does not distinguish between the carcinomatous and the benign gastric ulcer except in the late stage (Carman 16, Baetjer and Friedenwald 5). Surely hypoacidity is no criterion as Hartman (46) has emphasized. Probably it is true as Nielson (65) contends that the greater number of carcinomatous ulcers are among the group with ulcer symptoms for less than 6 years. That this is no sure criterion however is evident from our Cases 2 and 3 and many other examples in the literature. Thomas (78) has also called attention to the relative infrequency of an ulcer producing an hour glass stomach being malignant. This immunity is only relative however. A callous gastric ulcer removed at any stage of its clinical course may prove malignant (MacCarty and Broders 53). MacCarty (55) has pointed out that those over 5 centimeters in diameter are usually carcinomatous. This is true but as Alvarez (1) remarks even when the crater is small the patient cannot be assured that he has not a carcinoma and the aim of medical practice should be the diagnosis and eradication of the carcinomatous ulcer before it has reached such a large size. For this purpose the cooperation of the internist and the surgeon is necessary in diagnosing the potentially carcinomatous lesion from early symptoms and in educating the laity to this danger. The time to attack the malignant gastric ulcer is in the months or years before signs of malignancy

have arisen and while the ulcer symptoms only are present (Finsterer 35).

The exact prognosis in this group of chronic carcinomatous ulcers cannot be separated satisfactorily in the literature from that of localized carcinoma of the stomach in general. There are available too few cases with correlated clinical and pathological findings together with the end result. It is surely clear however from example of such cases reported that the prognosis is dependent upon the extension of the lesion beyond the stomach (Eusterman 34, MacCarty and Blackford 5). Even in spite of delay of months or of years many such cases have had clinical cures (Peck 69, Hartmann 45).

On account of the danger of carcinoma the operation of choice for callous ulcer in the distal half of the stomach is partial gastrectomy. Balfour (7) has advocated cauterectomy. He reports 130 partial gastrectomies with 4 deaths subsequently from carcinoma (3 per cent) and 296 cauterectomy resections with 10 later fatalities from carcinoma (3.5 per cent) each apparently followed by the same risk of carcinoma recurrence. However a he suggests the larger ulcer as no satisfactory for treatment by local excision consequently a greater proportion of the more extensive carcinomatous ulcers are probably included in his resected group. So it seems that the two groups are not comparable for statistical purposes. Pauchet (61) reported better results from partial gastrectomy than following cauterectomy.

My personal observations though not sufficiently extensive to be conclusive have led me to the conviction that partial gastrectomy if technically feasible is far superior to any form of local excision. Two lesions of this type which were thought to be benign chronic ulcers were liberally excised with the cautery. Both recurred one 2 years and the other 4 years after operation. Both of the cases seemed favorable. In fact at operation there was nothing to suggest that they were malignant carcinoma being found only by histological examination. Two other cases at operation apparently less favorable than the former have gone after resection in one case 4 years (Case 2 of this paper) and in the other

6 years without evidence of recurrence. The most important item in the operation is the wide excision of the glands of drainage with the resected portion of the stomach. While in most cases a margin of 4 to 5 centimeters past the indurated tissue is ample to prevent local recurrence in the stomach itself (Ihalhimer and Wilensky 77) the operation should remove particularly the glands of the lesser curvature (Hartmann 44). In order to include these most of the lesser curvature is excised in the resection. For reestablishing the gastro intestinal canal Moynihan's modification of the antecolic Polya operation (64) has given us most satisfactory results. The immediate postoperative recovery is surprisingly smooth and the functional result is excellent. Wheeler (84) also remarks about how little postoperative reaction there is from this procedure. The mortality of such a resection for chronic ulcer is little if any greater than after local excision (Moynihan 64, 1.6 per cent; Finsterer 35, 2.3 per cent). If there is extension of obvious carcinoma outside of the stomach requiring formidable accessory procedures such as resection of the colon, the pancreas, or the liver, the operative mortality mounts (Finsterer 39). Such mortality statistics have no bearing upon the risk of resection for lesions that appear to be chronic ulcer. Partial gastrectomy then offers the only chance of cure for the lesion that is obviously malignant at operation and also the best chance of cure with a very low mortality for the callous ulcer in the pyloric half of the stomach.

#### HISTOLOGICAL TYPES REPRESENTED

All types of carcinoma are found histologically in these callous ulcers. Carcinoma simplex was illustrated in Case 1 and adenocarcinoma by Cases 2 and 3. Colloid carcinoma is less frequently found. In its early stages there is nothing to distinguish it clinically or in the gross from other carcinomatous ulcers. The following case illustrates this variety.

I G O S M H No 3494 male aged 43 was admitted to the hospital November 4, 1916 with the complaint of pain in the epigastrium and vomiting. The present illness dated back 3 years when he

began to vomit once a day, not accompanied by pain or nausea. After a year this subsided for several months. For 3 months before admission he had had epigastric pain, or 3 hours after eating relieved by vomiting or alkali. Vomitus had been of a coffee ground variety at times. Loss of 15 pounds had taken place in the last 3 months. Examination revealed some emaciation. Stool showed no occult blood.

A gastric analysis fasting free hydrochloric acid 9 per cent, total acidity 0 per cent, after Lwal test meal free hydrochloric acid 10 per cent, total acidity 7 per cent. Gastro intestinal X ray showed irregularity in the pyloric antrum (lesser curvature) and a 1.6 hour residue.

The preoperative diagnosis was gastric ulcer. At operation November 5, 1916 (by Dr. Morton) a large callous ulcer was found on the lesser curvature. Before resection there was no definite proof as to whether the lesion was benign or malignant. Its size (3 centimeters in diameter) and the induration around it suggested on gross inspection that it would prove to be a carcinomatous ulcer. Sections of the lesion showed colloid carcinoma infiltrating deeply into the base of the ulcer (Fig. 8).

Whatever the type of cell, all of these malignant callous ulcers share the characteristic of ulceration nearly co-extensive with the malignant proliferative process. In fact, the typical gross picture of chronic ulcer with an undermined oral edge and a terraced distal margin is frequently found. In the base or the edge of the ulcer the carcinoma cells may be very abundant or may be found only with difficulty. Thomson and Graham (79) and also Ihalhimer and Wilensky (85) have each reported a case in which multiple sections failed to demonstrate any carcinoma but in which the latter was found in the lymph glands. Usually cords of malignant cells invade the base, infiltrating between the muscle bundles. Sometimes however the carcinoma is confined to one area with a typical ulcer scar, most of which is uninvaded by the malignant process. This latter is the only type which Dible considers. Clinically it cannot be differentiated from the primary carcinomatous ulcer (Dahl Iversen 3, and Duplant 31) and its prognosis is the same. There is no definite correlation between cell type and prognosis (Brodnitz 14, von Haberer 43, and Weil 83) except that the colloid carcinoma usually spreads throughout the peritoneum and if the stomach is removed before the malignant cells reach the serosa

there is less danger of lymphatic metastasis having already occurred (Denver 24 and Duggan 9). The results of resection of the stomach however do not show any great difference in colloid carcinoma from the other types (Jarrah 66).

Recently Broders (11) established a correlation between the degree of malignancy and the histological differentiation of cellular structure of carcinoma of the lip. This principle has been found to apply in certain other malignant tumors (Greenough 4). Carcinoma of the stomach also has been studied from this point of view by MacCarty and Mahle (4) and Broders and MacCarty (13). There is a slightly longer survival in the group showing the greater cellular differentiations but this correlation is not nearly as important as in carcinoma of the lip and breast.

#### SUMMARY

Historically there has arisen a controversy over the malignant degeneration of chronic gastric ulcer. This protracted debate concerning the pathological mechanism has detracted attention from the significant clinical fact that there is a type of carcinomatous ulcer which mimics exactly chronic gastric ulcer in its symptomatology and physical and X-ray manifestations.

As Mel on title the point of view of the surgical pathologist should be that one can never be too reserved when dealing with the diagnosis of *carcinoma ex ulcere*. However of far greater importance to the patient the point of view of the clinician (both the internist and the surgeon) should be one can never be too certain in the differentiation of chronic gastric ulcer from carcinoma.

As there is no sure way of distinguishing clinically between the benign and malignant callous gastric ulcer all such ulcers ought to be considered and treated as carcinoma suspects. The doctor who temporizes with chronic gastric ulcer may be robbing that individual patient of cure and opposing the education of the laity in regard to the early diagnosis and radical treatment of gastric conditions that may be carcinomatous. The hopeful phase of the treatment of gastric cancer is the radical removal of the lesion

before the development of the classical signs of malignancy. In a large number of gastric carcinoma cases the lesion is inoperable when symptoms first manifest themselves. These ulcer carcinomata do not fall into the above group but are characterized by symptoms for months and often years before they are so extensive as to prevent resection.

Pathologically such lesions seem usually to be slowly growing primary localized carcinomata in which the ulcerative process is nearly co-extensive with the neoplasm. In a small number however there is pathological evidence that the carcinoma has developed upon a true chronic ulcer, the classical *carcinoma ex ulcere*. These pathological type cannot be distinguished clinically and often not in the gross specimen.

All type of carcinoma may be found in the malignant callous ulcers. There is not sufficient data upon which to base a differential prognosis separate from other localized gastric carcinomata or according to the cellular type represented. When resection is feasible the result in a 25 per cent 5 year freedom from recurrence.

The difference of clinical opinion about the danger of carcinoma in chronic gastric ulcer seem to be due chiefly to the type of case studied. A classification is suggested which will assist in differentiating similar group for comparison and in ruling out of consideration the large number with inadequate data for localization.

Limited to those cases presenting ulcer symptom over a period of months or year with definite X-ray evidence of localization in the stomach clinically diagnosed chronic gastric ulcer will prove carcinomatous in 10 to 20 per cent.

#### CONCLUSIONS

1. The controversy concerning the development of carcinoma from chronic gastric ulcer has obscured the significant clinical relationship of the two conditions.

It is frequently impossible to differentiate clinically the malignant from the benign callous gastric ulcers in the stage when cure is still possible. It cannot even be done with certainty at operation in many cases.

3 As a corollary to this fact all callous gastric ulcers are carcinoma suspects and should be treated as such both before and at operation

I want to express my appreciation to Dr. Harvey Cushing and Dr. David Cheever for permission to include in this report the cases which I studied at the Peter Bent Brigham Hospital. I am indebted for the photomicrographs to Mr. A. P. H. Trivell of the Eastman Kodak Company.

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# DIFFERENTIAL DIAGNOSIS OF AMÆBIC DYSENTERY AND CHRONIC ULCERATIVE COLITIS BY PROCTOSCOPIC EXAMINATION<sup>1</sup>

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AMÆBIC dysentery, like chronic ulcerative colitis, produces certain characteristic and unmistakable lesions in the rectum and sigmoid. Their appearance in many instances even when repeated stool tests are negative has provided sufficient evidence for a positive diagnosis. Those who are conversant with this disease know that such remedies as ipecac and its derivative emetin hydrochloride and the arsenicals such as trepanol, stovarsol and arspenamine will often cure the diarrhoea and cause ulceration to heal within a period of 10 days. Such medication constitutes therefore a valuable therapeutic test which we often employ when stool examinations are negative although the ulcers are typical. The diagnosis has been uniformly confirmed by healing of the ulceration after treatment. Often when *Entamoeba histolytica* cannot be demonstrated in the stool it will be found in great numbers in the scrapings taken from the bases of the ulcers.

In the general run of cases the ulcers are discrete and the mucosa between them although not normal is so mildly inflamed as to seem relatively uninvolved. Of course in many cases of active diarrhoea due to *Entamoeba histolytica* the rectal and sigmoidal mucosa is normal or but slightly hyperæmic. However when the ulcers appear they are typically discrete and have no characteristics which might lead to confusion with any other type of rectal ulceration unless it is certain types of tuberculous ulcers and those associated with *Balanitidis coli*. As compared with chronic ulcerative colitis the ulcers of amœbic dysentery even in its earliest stage are not as small nor as numerous; they are much deeper and in the severe cases they increase in size. In chronic ulcerative colitis the military ulcers do not increase in size with severe attacks (although they become more numerous) and the large secondary infective ulcers seen as associated are not to be considered as a part of the characteristic picture.

The amœbic ulcer usually occupies a position on the prominent folds of the bowel wall or involves the valve of Houston. The margins are undermined by the infiltration of the ulcerative process and the prominence of the ulcer is further increased by the accumulation on the base (composed largely of great numbers of *Entamoeba histolytica*) and projecting above the ulcer margin presenting itself as a greyish white covering over the center of the ulcer known as the white cap. This term is familiar especially to those who live where the active disease is more prevalent. The white cap is easily swabbed away after which the true base of the ulcer is revealed lying below the surface of the overhanging margins. This is the explanation of the punched out or umbilicated appearance of the amœbic ulcer. It varies in size from about 1 or 2 millimeters in diameter (rarely so small) to a large sloughing ulcer 2 to 3 centimeters in diameter (or larger) with irregular margins and overhanging ragged edges seen usually higher in the colon. In the cases seen in the Mayo Clinic both of these extremes are the usual ulcer and there is usually a small zone of hyperæmia surrounding it. Of course in the acute cases with severe prostration and excessive stools sloughing and bleeding it will be difficult to identify any such ulcer the involvement is massive and diffuse and a single ulcer is seen only in the midst of a sloughing bleeding mucosa. Such extensive disease is rarely seen in the Mayo Clinic because it is almost entirely associated with acute tropical amœbic dysentery which is seldom observed here. Experience in the Clinic has been with the more chronic type and it is possible that this high percentage of cases with relatively uninvolved mucosa between the ulcers might not be duplicated in the experience of others especially in the localities in which the acute forms of the disease are predominant. During the course of any year in the Clinic the stools of about 6



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The existence of such a disease as chronic ulcerative colitis is far from being universally admitted. In some comparatively recent and comprehensive descriptions of diseases of the colon it is not specifically mentioned. Current articles sometimes pass it over. Many clinicians insist that it is an aberrant form of bacillary dysentery from which the typical organisms cannot be isolated and cases have been recorded of the successful use of polyvalent antidyenteric serum.

The pathology of the disease is confusing because the postmortem appearance is radically different from the sigmoidoscopic manifestations. By the time death occurs the mucosa is almost entirely destroyed and in the bloodless tissue all traces of the distinguishing features of the disease are lost.

Descriptions of the lesion as seen through the sigmoidoscope are conflicting. It has been described as recognizable at first glance as indistinguishable from that of bacillary dysentery and as presenting a clear cut clinical and pathological picture by different authors and by the same author. In the course of more than 20,000 sigmoidoscopic examinations since 1919 I have examined more than 600 cases of chronic ulcerative colitis. I have observed what I consider the typical lesion in the untreated state and during its progression and its healing under treatment. My description (4) is therefore not based on an occasional observation but on constant manifestations not presented by any other known disease.

Hurst has been unable to observe this type of lesion and fears that the disease in America is different from that seen in England. Indeed it was his suggestion that I might be confusing it with amœbic dysentery that prompted this paper.

I have not been able to find in the English literature a comprehensive description of the lesion as seen there through the sigmoidoscope, I can therefore make no comparisons. The clinical course however and the appearance at necropsy are practically the same here as in England.

Lockhart Mummery describes the appearance of the lesions at necropsy and under the sigmoidoscope and pays considerable attention to the larger and as I think less typical lesions 'the size of a pea up to large irregular tracts'. He suggests that the lesion seen with the sigmoidoscope is an earlier or milder stage than that observed at necropsy. He describes the former as granular and uses an illustration which is identical in many respects with my description.

The confusion that clouds the general attitude toward chronic ulcerative colitis will be cleared when observers of numbers of cases describe explicitly the appearance of the disease under the sigmoidoscope then only will the chasm that lies between observation and conviction be bridged.

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per cent of the patients registered are examined and *Entamoeba histolytica* is found in about 10 per cent of the cases. Brown in studying a series of cases of amoebiasis at the Mayo Clinic divided them into three groups as follows:

Group 1 153 cases 8.7 per cent in which active symptoms dysentery or liver abscess were manifested at the time of admission. In 34 per cent of these cases rectal ulceration was found on proctoscopic examination.

Group 2 258 cases 48.3 per cent in which the chief complaint or one of the complaints was intermittent spells of diarrhoea, sometimes alternating with constipation. Associated with this there were usually reflex abdominal symptoms borborygmus and in definite lower abdominal distress. In none of these was rectal ulceration present.

Group 3 122 cases 2.8 per cent in which the *Entamoeba* was found without recorded history of dysentery. These were the pure carrier cases. They were discovered in the careful study of patients in whom all possible sources of infection were sought which might be factors in conditions such as dermatitis, anaemia and indeterminate intestinal diseases.

A comparison of the rectal and sigmoidal lesion of amoebic dysentery with that of chronic ulcerative colitis shows that they are not alike in any particular except that both represent forms of ulceration and inflammation of the colon. They should be confused only in the massive diffusion of the severer cases. However even then if the individual elements entering into the composite picture are analyzed it will be seen that they are alike in no particular. In amoebic dysentery the ulcers are discrete and seldom smaller than millimeters, coalescence being present only in the very severe cases. In chronic ulcerative colitis diffusion is a feature in all cases from the mildest to the most severe (acute or chronic). The characteristic miliary ulcer occurs in much greater numbers and are seldom larger than 1 millimeter in diameter. The active period of the disease is characterized by stages of diffuse inflammation, oedema, miliary abscesses and miliary ulcers. From the bases of these ulcers a specific type of organism (described by Bargen) can be isolated. The dis-

ease is prone to begin in the rectum and extend upward. There are often larger ulcers present but these are due in all probability either to the invasion of the smaller ulcer by secondary infective organisms or continued activity of the diplococcus described by Bargen. Possibly both of these factors are responsible. The ulcers in no way resemble those caused by *Entamoeba histolytica*. The former have irregular margins without the undermining and a shallow base which is covered by a tenacious membrane which does not heap up. In such cases on rare occasions *Entamoeba histolytica* has been obtained on examination of the stool but scrapings from these ulcers did not show the organism and the therapeutic test failed to incite healing. In fact the arsenicals often increase the activity of the disease in cases of chronic ulcerative colitis.

In many instances the characteristic ulcer will heal either during a period of quiescence or after a course of vaccine treatment leaving small pock like scars behind as evidence of previous activity. The secondary ulcer however does not always respond to the vaccine and the resultant picture of pock like scar between the larger ulcers is just as significant diagnostically as the original ulcer was.

Another point of contrast is the constant tendency toward uniform tube like contraction of the lumen of the bowel in chronic ulcerative colitis. This is seen both on proctoscopic examination and in roentgenograms of the colon made after barium enema. In my experience such contraction is seen but rarely in amoebic colitis. The diameter of the bowel therefore tends to return to normal after the amoebic ulceration has been disrupted by treatment except in chronic cases following repeated severe attacks. In the very severely affected bowel of amoebic dysentery there is also distortion and scarring but it does not result in the uniformly narrowed pipe like colon seen after attacks of chronic ulcerative colitis. The tendency in most cases of the latter is for the contraction to remain permanent although recently we have seen some restoration of the normal lumen after vaccine treatment.

McArthur described a method of ureteral repair which I found to be very well adapted for experiment on dogs. This author left his catheters *in situ* for a period of 9 weeks but he went on to say that although ureteral regeneration is known to occur the rate of epithelialization of the ureter is unknown. The method described below is similar to that described by McArthur.

The method of bridging with a ureteral catheter was used in these experiments because it seemed to be the method of choice in view of our knowledge of the tendency of epithelial lined ducts to regenerate over a splint. The purpose of this paper is to recount observations on the rate of ureteral regeneration and not to advocate the method described in preference to any of the other known methods.

In performing the operation the main difficulty has been to prevent tearing into the peritoneal cavity which usually caused the death of the dog within several days. The primary mortality was very high so that the series of successful operations was small. However a number of interesting observations were made which it is hoped will be confirmed and added to in future experiments which are being contemplated.

#### TECHNIQUE OF OPERATION

Ether anesthesia was used. The lumbar region was shaved and prepared with iodine and alcohol. An incision was made through skin, fascia and muscles to expose one kidney. The kidney was delivered and the ureter located and dissected downward so that the middle third was exposed. In this portion was made a longitudinal incision long enough to admit two No. 5 ureteral catheters. One catheter was passed upward into the renal pelvis, another catheter was passed downward into the bladder and the ends of both catheters were brought out through the wound. At a point  $1\frac{1}{2}$  inches below the longitudinal incision the ureter was completely severed and the cut edges were brought together with one silk suture. The wound was closed by layers.

*Experiment 1* The operation was performed according to the technique previously described. The

upper catheter began to discharge urine immediately and continued to do so until both catheters were removed on the fifth day. A urinary fistula developed in the wound and remained open for 3 weeks although the amount of urine discharged became progressively less. During the fourth week the fistula closed and the wound healed completely. The dog was killed 4 weeks after operation.

*Postmortem examination four weeks following operation* Necropsy revealed the kidney on the side operated upon to be one half the size of the opposite one and considerable subcapsular scarring was seen throughout. The peritoneum overlying the ureteral incisions was smooth and glistening and not thickened. Slight kinking of the ureter was noted but otherwise there was little visible manifestation of the ureteral anastomosis. Palpation of the ureter revealed peri ureteral fibrosis limited to the area of anastomosis and ureteral drainage. Fluid injected into the lower ureter passed the area of anastomosis without obstruction distending the pelvis of the kidney. Examination of the lumen showed two areas of constriction, one at the line of anastomosis and the other at the point of longitudinal incision for insertion of the catheters. The latter was more marked. The mucosa in the involved area was grossly unaltered and only slight dilatation of the upper ureter and pelvis was noted.

Sections of the kidney revealed evidences of interstitial inflammatory involvement with only slight changes in the tubular and glomerular structures. Sections of the ureter in the area of operation were normal as compared with the other ureter except for rather marked peri ureteral fibrosis.

*Experiment* The technique of the operation was exactly as described. On the fifth day the catheter leading from the kidney pelvis was removed and the catheter leading to the bladder was left *in situ*. Previously urine drainage through and around the upper catheter was good. Following this a urinary fistula persisted until the time the dog was killed 2 weeks later. The general condition of the dog was good throughout this period.

*Postmortem examination two weeks following operation* The kidney on the side operated upon was one and one half times the size of the opposite kidney. The consistency was softer but otherwise the appearance was quite normal.

The peritoneal surfaces in the region of operation were smooth and glistening but some thickening could be palpated. The ureter in the area of the incisions was markedly kinked and imbedded in a mass of dense scar tissue. A fistulous tract was found in this mass extending from the ureter to the outside in which was found the lower catheter extending down the ureter to a point several inches above the bladder. The fibrous periureteral thickening was fairly well limited to the upper ureteral wound and fistulous region although it extended downward to the area of anastomosis where peri ureteral scarring was much less marked. The ureter above the fistula and the renal pelvis were definitely

## OBSERVATIONS ON THE RATE OF URETERAL REGENERATION

## PRELIMINARY REPORT

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THE problem of repair following ureteral injury became interesting to me some years ago when I witnessed in one of our charity hospitals three ureteral accidents in a period of 3 months. Since these occurred while the patients were under the care of a gynecologist of experience and unquestionable ability it follows that similar injuries must be observed in other clinics where the same extreme pathology is encountered. It must be admitted that many ureters could be saved if ureteral catheters were passed and left *in situ* during difficult pelvic operations involving large inflammatory and neoplastic masses. On the other hand even with the utmost precautions ureteral accidents are apt to occur from time to time.

Opportunities to attempt ureteral repair are very few even with surgeons having large private and charity services with the result that our knowledge of ureteral healing is poor. That healing and epithelization does occur with any of the numerous methods of anastomosis is an established fact but the rate is unknown. Our knowledge of the rate of healing of a severed urethra anastomosed over an indwelling catheter indicates a rapid and complete reestablishment of urethral continuity usually within 10 days so that the catheter may be safely removed at that period. The tendency of an epithelial lined duct to regenerate along a splint in the biliary passages and also in the vis deferens is well known. In the latter the sheath alone may act as a bridge and regeneration may progress with reestablishment of the lumen.

The effects led me to believe that epithelization and repair of a severed ureter would occur with equal rapidity and this conviction led to the experiments detailed below.

The three ureteral accidents previously mentioned occurred in the course of very difficult gynecological operations. Two of these happened during radical Wertheim operations for carcinoma of the cervix. In

both instances the ureters were exposed and followed down to the bladder only to be ligated accidentally when troublesome hemorrhage from the uterine vessels completely obscured the field of operation. In one case the patient developed a complete anuria and subsequent attempt to catheterize the ureters revealed bilateral occlusion. At autopsy the findings were confirmed. The second woman shortly after operation developed severe pain in the right renal region and cystoscopic examination revealed unilateral ureteral occlusion. Several weeks later nephrectomy was performed for hydronephrosis. The third accident was a complete severance of the ureter which had been displaced by a large pelvic inflammatory mass. Following the dissection and removal of the adnexal mass the ureter was found to be cut just below the brim of the pelvis. An anastomosis was immediately done according to the method of Van Hook. Urine discharged from the peritoneal cavity the next day and continued until nephrectomy was performed several weeks later.

Bickham discusses 16 different operations for uretero-ureterostomy and all of the failures into one of two groups—end to end and end in end anastomosis. End to end anastomosis may be performed without a support by transverse (Schopf-Cushing) approximation of the ureteral edges. Bovery's oblique and Van Hook's elbowing anastomosis are other methods of end to end repair without a support. The Tuffier and Kelly method consists of suture over a ureteral support which is removed when the sutures are in place.

Markoe, Poggi, Kelly and other have described method of end in end anastomosis which differ from each other only in detail. Van Hook's uretero-ureterostomy by peritoneal ligation and end to side implantation is recommended by many as the best for all around use. Young advocates simple end to end suture over a ureteral catheter passed from the bladder to the renal pelvis.

the thickened scarred area thus locating exactly the site of ureteral regeneration.

A ureteral catheter No. 4 passed upward from the bladder was obstructed at the site of anastomosis. Fluid injected through the catheter passed beyond the anastomosed area and escaped through the fistulous opening located about 1 inch above the point of obstruction. After the fistulous opening was closed with a purse string suture fluid injected with considerable pressure passed upward and distended the upper ureter and renal pelvis. Following the above procedure manipulation of the ureteral catheter resulted in its free passage by the affected area into the pelvis.

When the lumen of the ureter was opened the area of regeneration was found to be constricted to about one third the diameter of the portion below. This area measured about  $\frac{1}{4}$  inch in length. About 1 inch above the internal orifice of the ureteral fistula was easily found. The upper ureter and kidney pelvis were definitely dilated. The mucous surface in the affected portion was similar in gross appearances to the adjacent portions above and below.

The three experiments cited were selected for report and discussion because they demonstrate results which appear to cast some light on the rate of ureteral regeneration and epithelization. It would appear that the tendency is rather to overrate the time necessary for regeneration and canalization of epithelial lined ducts. In 2 of the above experiments (1 and 3) the splints were removed on the fifth day and in both instances ureteral continuity with a patent lumen was reestablished at the time of necropsy 3 and 4 weeks later. In one of these (Experiment 3) a gap of  $\frac{3}{4}$  inch was left between the severed ureteral edges while in the other (Experiment 1) the ureteral edges were approximated with only one suture. In these cases the amount of periureteral fibrosis was much less marked and the anatomical result much better than in Experiment 2 where the ureteral splint was left *in situ* for 14 days.

The evidence is very definite that ureteral repair and epithelization occur very rapidly since a perfect anastomosis was found in dog 2 at the end of 14 days with the splint in position during the entire period. The fact that a successful anastomosis and canalization occurred after only 5 days of bridging should emphasize the probability of sufficient regeneration at that period to insure reestablishment



Fig. 3. Section of ureter of Dog 2 in the region of the anastomosis showing marked periureteral fibrosis.

of continuity and lumen even when a definite gap exists.

In the literature on ureteral anastomosis great emphasis is placed on the prevention of leakage of urine at the point of anastomosis and the statement is frequently made that leakage retards or actually prevents ureteral healing. It would appear from these experiments that splinting is the more important factor although diverting the urine as was done with the upper catheter may have been an important factor in determining the rapidity of the healing of the severed ureteral edges.

The periureteral cicatricial reaction observed was in all probability caused more by the presence of the catheters than by leaking urine and infection. Rapid closing of the ureteral fistula occurred when the catheters were removed within 5 days demonstrating the desirability of a much shorter splinting period than that used by McArthur.

Some stenosis of the lumen may be expected with any type of ureteral anastomosis and is apt to be more marked if the method used resembles that advocated by McArthur. Stenosis should be combated by lowering the period of bridging thus diminishing the amount of periureteral scarring. Ureteral dilatation would appear to be indicated in all



Fig. 1. Section of the kidney showing the ureter.

dilat d. A ureteral catheter put up the ureter from the bladder passed by the area of anastomosis making its exit through the fistula. Like the catheter passed downward from the renal pelvis emerged through the fistula.

When the ureter was opened along its entire course a fine annular scar with practically no constriction was found at the point of anastomosis. Above this point where the ureter was imbedded in scar tissue the lumen of the ureter was slightly constricted and communicated with the fistula. The upper portion of the ureter was dilated.

Microscopic sections of the kidney and ureters were essentially the same as in the previous experiment except for a much greater amount of perireteral fibrosis.

**Experiment 3.** The usual technique was used with the following exception. Instead of merely securing the ureter about three-fourths of an inch was excised and the edges were allowed to remain the above distance apart over the usual ureteral splint. One loose silk suture was used to prevent further retraction of the ureteral edges. Urine began to be expelled from the upper catheter at once. Usual closure by layers followed.

On the fourth day both catheters were removed. Urinary fistula developed in the wound which continued to discharge urine until the dog was killed 3 weeks after operation. At that time a small clean fistulous tract remained and the general condition of the dog was good.

**Postoperative condition three weeks following operation.** Thickening of peritoneum overlying the affected region was noted with a few easily torn omental adhesions. Both kidneys were grossly similar as regard size, appearance and consistency.



Fig. 2. Ureter showing the site of the recent partial procedure as easily indicated because of the perireteral thickening and adhesion of the ureter to the surrounding structures. In this case (about 1 inch) the ureter was lost in a mass of scar tissue.

The affected ureter was thickened throughout its entire length. The site of the recent partial procedure was easily indicated because of the perireteral thickening and adhesion of the ureter to the surrounding structures. In this case (about 1 inch) the ureter was lost in a mass of scar tissue. Above this point it was dilated to about one and one-half times the size of the ureter below. Dissection within the scarred area revealed perfect continuity made at the anastomosis and very little thickening. In the area of cicatrization a small fistulous tract was discovered extending from the lumen of the ureter to the external wound. The silk suture was found in the lower portion of

## A CYSTOMETRIC STUDY OF THE PHARMACOLOGY OF THE BLADDER

WITH ADDITIONAL DATA REGARDING THE PHYSIOLOGY OF URINATION

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THIS work has been undertaken to determine the experimental value of the cystometer in the pharmacology and physiology of the urinary bladder as well as to furnish further proof of the correctness of the ideas of bladder innervation used to formulate the clinical principles of the instrument as given previously (4 and 5).

The cystometer (Fig. 1) utilizes the total innervation of the bladder in that as the viscus fills the changing capacity with its pressure is measured and a curve recorded between the bladder capacity in cubic centimeters of water and the intracystic pressure in millimeters of mercury. In all previous attempts to determine bladder function either isolated strips of muscle from different portions of the bladder have been immersed in solutions containing various drugs and their response recorded graphically or a given constant amount of water has been placed within the bladder the nerve supply of which is then stimulated either through dissection allowing direct electrical stimulation or by various drugs used hypodermically and the action of either type of stimulation determined by the contraction or relaxation of the bladder upon this given amount of fluid. Obviously this latter method is incorrect in that the bladder has no given capacity and to measure its changing size and tonicity it would be necessary during these changes to keep it completely filled. This is accomplished when the cystometer is used.

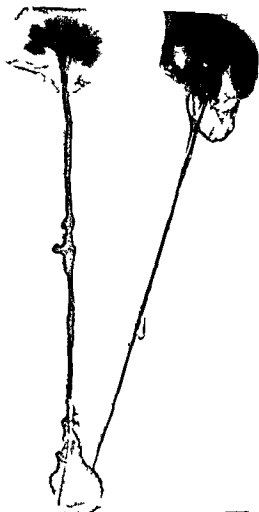
The work done so far in the clinical use of the cystometer has been based upon the fact that the bladder wall and its internal sphincter are chiefly in control of the sympathetic and parasympathetic nerves and that in general whenever sympathetic meets parasympathetic in a dual nerve supply to any organ or tissue the effects of the two are antagonistic (3). Upon stimulation the sympathetics with outflow from the second

dorsal to the third lumbar anterior roots passing by way of the inferior mesenteric ganglions and hypogastric nerves contract the internal sphincter and relax the bladder wall and are therefore considered the nerves of bladder filling, whereas the parasympathetics from the second and third sacral segments form the pelvic nerves stimulation of which contracts the bladder wall and relaxes the internal sphincter and are therefore the nerves of bladder emptying. One other action has to be considered namely that of the external sphincter which is best considered as the resistance to the bladder wall external to the internal sphincter. The reason for this consideration is that there are in the so called external sphincter so many influences that no one muscle can be held responsible for this resistance (Chart 1).

In further explanation of this idea we have recently discovered in the clinical use of the cystometer an entirely new explanation for a type of urinary retention which occurs when the lesion irritates or destroys the innervation of the external sphincter muscles (nervus pudendus chiefly). We would in such instances have left a normal sympathetic and parasympathetic system but with a large retention due to the fact that the paralyzed or spastic levator prostatae (anterior portion of the levator ani muscle) will not institute the downward and backward motion of the prostate and bladder base necessary to its emptying.

With a cystoscope just at the internal orifice the trigonal portion of the bladder is seen to be pulled downward and backward (6, 7 and 8) when the patient is asked to strain as in voiding. The direct depression of the floor of the internal sphincter and the posterior urethral pull is due to the trigonal and in part to the recto urethralis muscle but the chief posterior and slightly downward motion is due to the levator prostatae portion of





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cases especially if a gap has previously existed. Dilatation should be performed as soon as possible because of the danger of contraction of the perureteral scar. The hydronephrosis and hydro ureter which is found in some degree following any ureteral anastomosis may be rendered less marked by timely ureteral dilatation.

#### SUMMARY

1 Ureteral injury may occur during the course of difficult gynecological operations and during the operation indwelling ureteral catheters should be used as a precaution against such accidents.

2 Ureteral regeneration, canalization and epithelization occur rapidly when a ureteral splint is provided.

3 The period of splinting or bridging should not be unduly prolonged because of the tissue reaction aroused by the foreign body. It appears that a splinting period of 5 days is ample to allow reestablishment of ureteral continuity.

4 Ureteral stenosis may be expected with every case of ureteral anastomosis and is

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more marked in cases in which an actual gap between the ureteral edges has previously existed.

5 Ureteral dilatation is always indicated following ureteral operations and should not be delayed too long.

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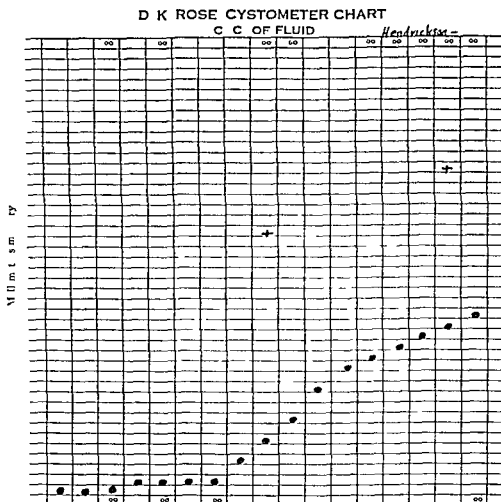
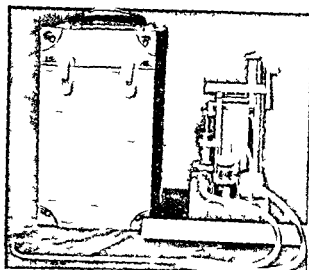


Chart 1 Dots show the intracystic pressures caused by contraction of the bladder wall alone. Crosses show the straining intracystic pressures. The cardinal cystometric points are: (1) Normal first desire to void at 150 cubic centimeters (2) only slightly delayed overdistention pain at 400 cubic centimeters (3) large capacity with mounting pressure and without ejection of catheter (4) high voluntary intracystic pressure—52 milligrams at 400 cubic centimeters—and 60 milligrams at 900 cubic centimeters (5) low initial bladder wall pressure due to large residual urine effect on bladder wall (6) muscular decompensation (6) low emptying pressure taken as each third of the bladder emptied also howing muscular decompensation of the bladder wall. In summary we have no mal sensation therefore normal motor autonomic as both types of fibers take in the same nerves decompensation of the wall but with more than sufficient voluntary pressure necessary to empty the bladder. Such a complex suggests bladder neck obstruction as the voluntary emptying through a catheter is of good force. Cystoscopic examination was negative except that when patient strained the floor of the interior sphincter did not move downward or backward. The motions brought about by the levator prostatae muscle. Cystometric diagnosis: lesion of anterior roots low cord. Operation was done by Ernest Sachs whose operative note states: Conus found under the tenth spinous process at the exit of its roots and studded them many small masses resembling tubercles were found. No specimen removed.

showed that the pressure and capacity had both been decidedly changed. This definitely indicates the antagonistic action of pilocarpin which is a parasympathetic stimulant.

The degree of antagonistic action in Chart 2 is better understood by comparing it with Chart 3 in which the normal pressure having

been established as indicated on the chart 10 cubic centimeters of 4 per cent cocaine solution was introduced within the bladder. This resulted in a marked relaxation of the bladder muscle which represents in degree the condition present when a cocaine solution is used prior to urethral or bladder manipulations.



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the levator ani muscle. In the normal male micturition is voluntarily initiated and in our study is the first motion in the act of urination is this voluntary depression of the internal orifice and prostatic urethra and then the involuntary action of the trigonal portion of the bladder with which action the lateral walls of the orifice are relaxed by virtue of the loop muscles about it (6). The contraction of the trigonal muscle foreshortens the supramontane urethra and institutes the involuntary emptying contractions. Without the action of the levator prostatae we have obstruction by virtue of the curve of the posterior urethra and its consequent angulation at the membranous urethra. Voluntary retention is made possible through the levator prostata by elevation of the internal orifice which effects an increase in the sharpness of the curve at the deep transverse perineal muscle and triangular ligaments thereby increasing the resistant pressure here.

Female dogs were used exclusively in this study. Each animal was anesthetized with paraldehyde by mouth 15 cubic centimeters per kilogram of body weight being used. The cystometric curves were made after the dog

was perfectly quiet which required from 30 to 90 minutes in time. They were catheterized with a 16 French female metal catheter. The urine was examined each time to be sure there was no infection. Several pressure readings were always made with each dose before the administration of the drug under consideration. Invariably the capacity of a dog's bladder is from 15 to 20 cubic centimeters more in the first cystometric examination than in any subsequent curve. We attribute this to the stimulation of the first filling resulting in an increased tonicity of the bladder wall. The same observation is easily made when irrigating the human bladder in which the patient almost invariably tolerates a much larger amount of the irrigation fluid the first time than during the several succeeding fillings. After the first reading a more or less definite capacity and intracystic pressure is established which is maintained quite definitely. One of these later cystometer curves we consider in each case as the normal intracystic pressure. At this point the drug under consideration is administered. The bladder is filled by the cystometer with sterile water at a constant slow rate of filling. When the limit of capacity is reached the fluid is expelled around the catheter. This point is marked on the curves presented as I f C (voids around catheter). The drugs were given in the order of their description and with definite times allotted between their administration.

In Chart 2 the inhibitory effect which atropin has upon the parasympathetic nerves is first shown. The reading starts with a zero pressure in an empty bladder and gradually mounts to 8 millimeters of mercury with a 55 cubic centimeter capacity. Having established a normal curve we gave atropin sulphate 1/10 grain subcutaneously. Ten minutes later the terminal capacity had increased from 55 (in the normal) to 90 cubic centimeters of fluid and the terminal pressure had decreased from 8 (in the normal) to 18 millimeters of mercury. We consider this distinct evidence of parasympathetic inhibition. Immediately following this reading pilocarpin hydrochloride 1/5 grain was given subcutaneously and 6 minutes later a reading

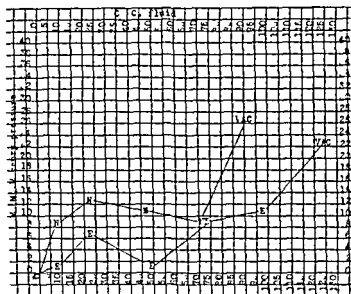


Chart 4 \ Normal E epinephrin

of an unusually large capacity with low pressure. Following the injection of 0.00 grams of ergotamine tartrate intramuscularly a curve was recorded after an interval of 0 minutes which showed an abrupt contraction of the bladder. Immediately afterward 1 cubic centimeter of 1:1000 epinephrin was given and 1 minute later a curve was made which showed its antagonistic action to ergotamine tartrate by the distinctly increased capacity. However there remained a residual high intracystic pressure from the ergotamine tartrate.

In Chart 7 a further composite picture is recorded in that after establishing the normal pressure 1 cubic centimeter of pituitrin was given intramuscularly producing bladder wall contraction by its direct action upon the muscle. Following this 1 cubic centimeter of a 1 per cent solution of curara (approximate strength) was given intramuscularly. The animal soon became flaccid and with slowed jerky respirations. Five minutes after the curara was given curve C was recorded which shows an increased capacity to 195 cubic centimeters with a voiding around the catheter pressure of 30 millimeters of mercury. This increased capacity probably represents a direct action of the curara on the bladder musculature. Following the curara by 10 minutes 0.002 grams of ergotamine tartrate was given. There was a slight decrease in the capacity so that in 10 minutes 0.003 grams

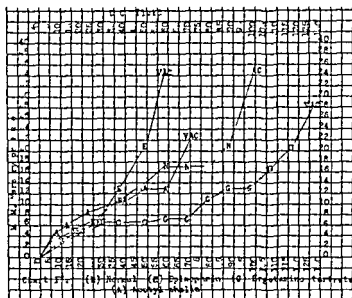


Chart 5 \ Normal E pinphrin G ergotamine tartrate 1 cc tylochin

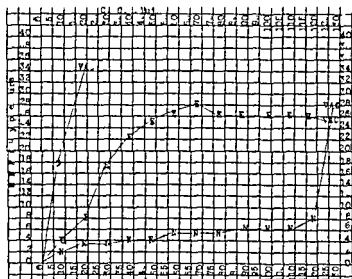


Chart 6 \ Normal G ergotamine tartrate F epinephrin

more of ergotamine tartrate was given and 23 minutes from this time we obtained the curve recorded here that is a marked contraction of the bladder. Again following the ergotamine 15 cubic centimeters of 1:1000 epinephrin was given intramuscularly and in 4 minutes there was some release of the bladder contraction in that the capacity increased to 50 cubic centimeters. It was noted following this that there was a very slow settling to the base reading which is indicative of sympathetic stimulation. The settling to the base line is much more rapid after parasympathetic stimulation.

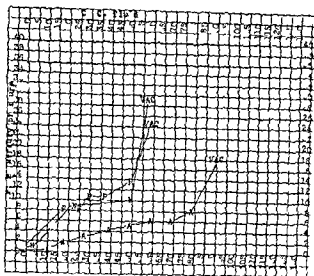


Chart 1. Normal Cat Pilocarpin

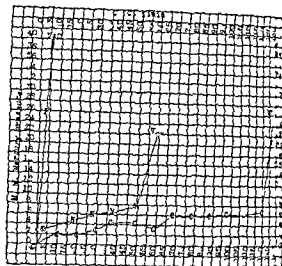


Chart 2. Normal Cat Cocaine Pilocarpin

as a local anesthetic that is decreased tone of the bladder wall indirectly lessens pain as well as the local anesthetic action of the anesthetic used. Immediately following pilocarpin hydrochloride  $1\frac{1}{3}$  grm was given intramuscularly resulting in an overwhelming stimulation of the parasympathetic.

Epinephrin is one of the most important drugs we have in the study of the sympathetics. Elliott (2) believes its action in dogs and cats is different in that he finds no inhibitor fibers in dogs whereas they are definitely present in cats. We feel that they are undoubtedly present in man and in our work are shown to be present in the dog. We believe that epinephrin in small doses causes contraction of the bladder in large doses relaxation.

In Chart 4 after establishing the normal we gave 1 cubic centimeter of 1:1000 epinephrin intramuscularly and obtained full stimulation of the sympathetics in that the voiding around catheter point remained high and the capacity of the bladder increased showing a stimulant action of the sympathetics i.e. inhibition of the bladder fundus and stimulation and contraction of the internal sphincter.

In Chart 5 the action of small doses of epinephrin is demonstrated i.e. bladder contraction following the intramuscular injection of 0.5 cubic centimeter of 1:1000 solution. If with this type of reaction the motor portion of the sympathetics could be cut out

we should then have left the amount of relaxation resulting from stimulation of the inhibitor fiber. Dale (1) carried through this side with the use of ergotoxin and for the same purpose we have used ergotamine tartrate (trade name Ergonovon). Immediately after recording the epinephrin curve 0.005 gram of ergotamine tartrate was given intramuscularly and we obtained a markedly increased capacity with lowered intravesical pressure as shown by the chart. This is of particular interest as in subsequent charts ergotamine tartrate not influenced by epinephrin produces distinct contraction of the bladder and in this case we can deduce only that the sympathetic inhibitors stimulated by the epinephrin are left in major control the motor sympathetics being cut out by ergotamine tartrate.

Acetylcholin stimulates the parasympathetics and when used immediately following ergotamine tartrate we find its definite influence as we would expect i.e. a decreased capacity and a lowered voiding around the catheter point or in other words contraction of the bladder and relaxation of the internal sphincter upon which the counteraction of the motor sympathetics is cut out.

To test further the value of this method and to check the action of the drugs Chart 6 is presented in which the administration of ergotamine tartrate and epinephrin is reversed in order. The normal curve was established which in this particular instance was

THE FORM CHANGES IN THE HUMAN UTERINE GLAND DURING THE MENSTRUAL CYCLE<sup>1</sup>BY JAMES I. OLEARY, S.B. AND CAROL CULBERTSON, M.D., F.A.C.S. CHICAGO  
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THE external appearance of the glands of the corpus uteri and their changes in form during the menstrual cycle have not been adequately visualized. The methods previously used, namely, the study of serial sections and in one case of wax plate reconstruction (Baumgartner, Nelson and Dock, 1920) have been more or less adequate for the interpretation of the simpler gland forms but they do not give any conception of the great variability in the form of the complicated glands of the later stages of the uterine cycle.

The classical description of the uterine gland presented a slender tubule coursing perpendicular to the surface and ending simply or after dichotomous division at the tunica muscularis. Sinuosity of occasional glands was accepted as normal.

Leopold (1877) correlated the slender tubular gland with the period immediately following menstruation and recorded their transformation into sinuous or alveolated glands as the succeeding menstrual period was approached. From our present point of view his carefully selected cases proved that such changes are normal but there were not many of them and the time was not yet ripe to establish correlations. It remained for Hirschmann and Adler (1908) to demonstrate the cyclic significance of the transformations undergone by the endometrium.

Opitz (1899) although cognizant of Leopold's work, described the papillary appearance of the hyperplastic uterine gland in early decidua and regarded it as diagnostic of pregnancy. While admitting the constancy of the papillary type of gland in pregnancy, Hartje (1907) pointed out that it is also regularly found in non-pregnant uteri during the period preceding menstruation. Hirschmann and Adler (1908) with a wealth of material at their disposal showed that the so-called decidual glands regularly occur in the period preceding the menstruum and proposed them as one of the criteria of what they term the

premenstrual stage. It was not until their work was understood that C. Ruge's endometritis glandularis came to be regarded as a normal stage of activity.

The portion of the endometrium lost at menstruation and the form of the remaining glands have received extensive consideration. It was said by Hirschmann and Adler and verified by Iwase (1908), Schroeder (1914) and others that the mucous membrane incurs little loss upon the first day of menstruation, the maximal sloughing of the functional layer (namely, that portion of the mucous membrane which hypertrophies for the implantation of the ovum) occurs upon the third day, usually at this time only the basal portions of the glands remain. Usually the fourth day shows the beginning of regeneration (Schroeder) and the fifth day a continuous surface epithelium overlying a low functional layer containing short, straight reconstructed glands. Hirschmann and Adler (1908) and others have questioned the loss of tissue at menstruation in some cases.

## METHODS AND MATERIAL

Our method utilizes free hand sections 0.1 to 0.5 millimeter in thickness cut with an auto-strop razor blade from material in 80 per cent alcohol after prompt fixation in Zenker stock solution or the like. The sections are iodized, washed and stained in Delafield's hematoxylin (before the addition of methyl alcohol and glycerin) diluted one part to five of water and one drop of glacial acetic acid added per 2 cubic centimeters of the diluted hematoxylin. The sections should be agitated occasionally to insure even staining. They are passed through tap water, dehydrated, cleared in oil of wintergreen (synthetic) and mounted in balsam. This method recommended by Professor R. R. Bensley (Goetsch, 1910) gives an adequate idea of the external form of even the complicated pre-gravid glands and makes possible a rapid sur-

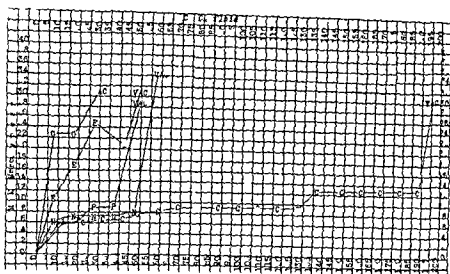


Chart V Normal Posture Cervical Gecomme Epiph

### CONCLUSIONS

1 The cystometer furnishes a new method for studying the physiological and pharmacological actions of the bladder

Results obtained by various drugs corroborate very satisfactorily the basic principles used in clinical cystometric work

3 Atropin acts as a parasympathetic inhibitor while pilocarpin acts as a parasympathetic stimulator Epinephrin in small doses causes contraction of the bladder and in large doses causes relaxation Acetylcholin is a parasympathetic stimulator Iritutin produces increased bladder wall tone

4 The antagonistic pharmacological action between drugs can be beautifully demonstrated the same antagonistic action has been found clinically in certain types of diffuse cord lesions

5 Through the clinical use of the cystometer the following steps in the complete physiology of micturition in the male have been evolved (a) Voluntary depression of the internal sphincter and prostatic urethra by the levator prostatae muscle (to a less extent

by the rectourethralis) its assistance in opening the internal orifice straightening out the curve of the posterior urethra and thereby lessening the resistant angle at the membranous urethra which is compressed by the deep transverse perineal muscle (b) Contraction of the trigonal muscle further opening the orifice by depressing its floor and shortening the posterior urethra (c) Contraction (or parasympathetic action) of the bladder wall by contraction instituted by or with the contraction of the trigonal muscle and having to do with it the relaxation of the loop muscles of the internal orifice

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to the same extent

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other variable features. Thus the fifteenth day of a thirty-five day cycle may resemble the tenth day of the Schroeder classification and is thus regarded as belonging to the beginning of the proliferative stage. This provides also for those specimens removed after 16 or 17 day menstrual flow which upon the fifteenth day of the cycle for example are likely to be more retarded than mucous membranes from cases with 13 day flow at the last period.

#### DESCRIPTION

*Early proliferative phase* CC 148 thirteenth day. The mucous membrane varies from 1.2 to 3.0 millimeters in thickness as measured in 80 per cent alcohol.<sup>1</sup> With the exception of a thin strip of lamina basalis (Schroeder) adjoining the muscle the entire stroma has the appearance of granulation tissue. The glandular epithelial cells are high columnar and in the early stage of secretory activity. Mitoses are active in both the gland epithelium and the stroma. Occasional lymphocytes, eosinophiles and plasma cells are to be found in the stroma. The appearance of a histological section of a similar stage is shown in Figure 1 (CC 51 eleventh day).

The glands are sparse or moderately abundant and show little variation in form (Fig. 2). They are slender cylinders with narrow lumina which expand uniformly from narrow superficial foveolæ toward the tunica muscularis at which they end in slight expansions or after branching in short vertical tubules. Bifurcation may occur in the basal half of the mucous membrane and is occasionally found superficially as well (Fig. 2 *Br 1*).

From the portions of the glands surrounded by the denser fibroblastic stroma of the lamina basalis vertical tubules (Fig. 2 *BB*) arise which project for varying distances into the granulation tissue stroma of the functional layer and which have no connection with the surface. However since they reach a much greater length in older mucous membranes we may assume that they eventually reach the surface and establish new glands thus serving to increase the number of glands in later

stages. Such outgrowths from the basal zone have not been previously recognized and we would suggest calling them *basal buds*.

CC 288 twelfth day. The mucous membrane is 1.9 to 1 millimeters thick and presents a later stage in that the stroma is composed of more mature connective tissue than in the preceding specimen. The gland cells are in the early phase of secretory activity. Mitoses are observed in both the gland and stroma elements. Plasma cells, lymphocytes and leucocytes are observed.

Figure 3 shows entire glands from this endometrium isolated by acid maceration. The typical form of the early proliferative stage is seen. The basal ends of some glands branch irregularly and slender basal buds may spring from the portion of the gland in the lamina basalis and extend a variable distance toward the surface (Gland 1 *BB*). It will be noted that the glands are somewhat more irregular than in the previous case and are more plump in form.

*Late proliferative phase* CC 141 fifteenth day. The mucous membrane is 1.8 millimeters thick. An early phase of secretory activity is common in the glands and there is no evidence of the storage of glycogen. Mitoses occur in both the gland epithelium and the stroma. Lymphocytes are the chief infiltrating cells and there are a few small lymph nodules. The stroma reticulum (cf Sekiba 193) has differentiated through the entire thickness of the mucous membrane whereas in the two specimens previously described it was not present in the superficial granulation tissue.

Figure 5 taken from a thick free hand section of this mucous membrane, shows moderately abundant straight glands which branch basally. Corresponding to the increase in thickness of the mucous membrane the glands are longer. Basal buds (*BB*) are a conspicuous feature. They are somewhat dilated with secretion and have grown considerably farther into the overlying stroma than in the previously described cases. A study of serial sections of this specimen demonstrated that the basal buds are not connected superficially either with other glands or with the surface. Furthermore the mitotic figures in such basal buds proved they were actively growing.

All b q t t m t f th th k f th m m mb l  
 t t m as t m d f th m t l 8 p m t l h l  
 th y m d m d t w t p m d y d y f th t  
 ul bl m d m w th f po ted d y d b oc l d  
 et g m p



vey of every part of an entire endometrium. Such a survey usually demonstrates regional differences which may not be neglected. It is a valuable rapid method of diagnosing pathological material.

Observations upon thick sections such as these were confirmed by the study of whole glands dissected from pieces of fresh mucous membrane which had been placed in one third concentrated hydrochloric acid and macerated for 1 hour (Schweigger-Seidel 1863). The work has also been controlled by a detailed study of thin sections.

Three hundred specimens which in the fresh state showed little or no gross pathology were selected from those removed in the clinic during the course of 3 years. The c were either entire uteri or frequently only fundi. The majority of these specimens showed some evidence of infection but such mild stroma inflammations do not appear to affect the gland as is obvious from a comparison with uninfected material. From this abundant collection sixteen mucous membranes have been selected representing typical phases of the uterine cycle as described by Schroeder and others.

#### CLASSIFICATION

The first study of the duration of the menstrual cycle based on records established with scientific accuracy (King 1906) confirm the early findings of Foster (1889) and makes it obvious that the regular twenty-eight day cycle is very much of a fiction. King studied 17 women and kept accurate records for from 1 to 104 cycles in each case. The duration of the cycle of a given individual was found to vary about a single mode but the actual variability in duration of cycles was from 4 to 35 days although there is a distinct mode in the curve for all cycles studied at 27 to 28 days. Such findings accurately established mean that the statements of the average woman as to the usual duration of flow have very little scientific value.

More important is the fact that the various subdivisions of the cycle cannot be accurately fixed. Even in successive cycles of the same individual corresponding days after the flow are not necessarily exactly comparable and specimens removed on corresponding days of

the cycle may show marked difference from one to another especially as to the form and secretory activity of the gland.

Schroeder's scheme of the men <sup>strual</sup> cycle is outlined and illustrated by photomicrographs in his *Lehrbuch der Gynaekologie* (cf F 15). Barker's *Endocrinology and Metabolism* (1912) and Williams' *Obstetrics for Students* (1912) present the most satisfactory basis for subdivision. It may be summarized as follows:

1. *Proliferative phase*. Fourth or fifth to fourteenth days of the cycle. Slender tubular glands with high columnar epithelium. Progressively increased mitotic activity in both glands and stroma correlated with the ripening of a new granular follicle.

2. *Secretory phase*. Fifteenth to twenty-eighth day. Glycogen mucicarmine positive material and fat appear in the gland cell and then in the lumen. The gland becomes saw-toothed. Stroma cells enlarge superficially. The vessel hypertrophy. Correlated with this phase is the development of the corpus luteum.

Schroeder's term "secretory" as applied to this stage is not distinctive. Bartelmez (1917) has found that secretory activity is not confined to this period. As Meyer has pointed out premenstrual is very misleading. Pregravid is much more satisfactory and will be used throughout our description.

3. *Desquamatory and regenerative phase*. First to fourth or fifth day of cycle. Following leukocytic invasion and pyknotic in the superficial mucous membrane extrusion of blood and desquamation occur. Regeneration soon follows. Correlated with this phase is the degeneration of the corpus luteum.

We shall follow this except that it seems advisable to us to subdivide the last phase separating the desquamatory and reparative processes. The latter intervene between the first signs of re-epithelialization and the formation of a complete surface epithelium.

This scheme of Schroeder based upon his own material of over 700 cases and several hundreds more from the literature serves as a norm according to which specimens may be classified by their resemblance to a given stage of the cycle regardless of the length of the menstrual period, duration of flow and

Below the neck region the lumen is greatly dilated and the gland is more irregular. Here we find a flattened sinuous shape sometimes complicated by minor irregularities. In a few glands the walls are symmetrically sacculated. The lamina basalis is narrow and contains the slim branched tubules which represent the gland bases. Figure 1 presents a typical group of glands from this specimen.

CC 269 thirtieth day. This specimen is at the height of the pregravid phase. There is evidence of accumulation of glycogen and intense secretory activity. The superficial one half of the endometrium is very adenomatous but there is no evidence of blood extravasation or accumulation of leucocytes so characteristic of the period immediately preceding menstruation. There are many cells of the decidual type in the superficial stroma.

The glands present a very variable appearance. The most advanced forms are shown in Figure 13. In the superficial one third they have a narrow lumen and are wavy or may be irregular or spiral in form. A few continue as narrow spirals but many of them are expanded so as to appear as narrow folded ribbons (cf Fig 10) reaching a diameter of 0.5 millimeter near the lamina basalis. There are in other words transitions from early forms of pregravid glands to most complex types characteristic of end of menstrual cycle.

**Menstruation.** Distinct reduction in secretory activity, characteristic changes in the walls of the blood vessels and extravasation of blood into the stroma inaugurate a process of necrosis. It is still a matter of debate as to whether all of the functional layer is lost at each menstruation. The process at no time involves the lamina basalis, however, which itself may be of considerable thickness.

CC 107a first day. The mucous membrane is 1.9-3.0 millimeters thick. Many glands still show secretory activity. As a result of the accumulation of extravasated blood the superficial stroma is loosening and disintegrating, leaving the necrotic free ends of the glands to project into the lumen of the uterus.

The glands are crowded (Fig 14). While a few retain a slender wavy cylindrical shape throughout, the majority are oval in cross section and variable in width. Where the lumen

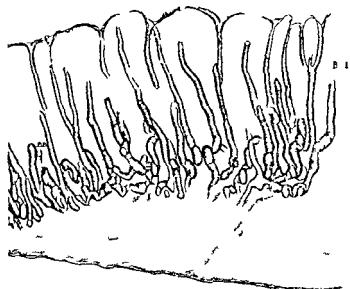
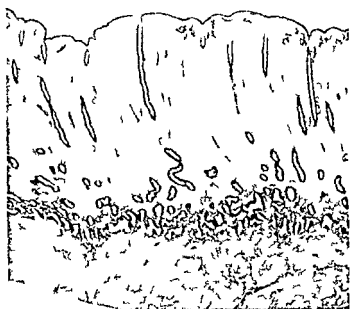


Fig 1 (above) CC 51 eleventh day. Photomicrograph of an 8  $\mu$  section from an endometrium in the early proliferative phase. Characterized by numerous mitoses and a stroma resembling young granulation tissue.  $\times 100$ .

Fig 2 CC 48 thirteenth day. A group of glands drawn from a thick free hand section of an endometrium in the same stage as that of Figure 1. Note slender gland branched basally and basal bud (BB) arising from the gland of the lamina basalis and directed toward the surface.  $\times 19$ .

is considerably enlarged the glands appear as folded bands, narrow at base but wavy. Many are irregular in form even at this level.

CC 83 first day. The mucous membrane is 2-3.1 millimeters thick. The glands resemble an early pregravid type and show little evidence of secretory activity. The superficial one half of the mucous membrane upon one side of the uterus is necrotic and sequestering

We have here the clearest evidence as to the way in which the number of uterine glands might be increased twofold in the course of a few days. To be sure this specimen might be regarded as a very early phase of hyperplasia but except for the numerous basal buds it appears perfectly normal. Figure 4 presents a photomicrograph of a thin section from a similar specimen.

*Early pregravid phase* CC 61 twentieth day. The mucous membrane is 3.0 millimeters thick. The epithelium is still in the early stage of secretory activity. The stroma is composed of mature connective tissue and is permeated by reticulum fibers. Mitotic activity has decreased as compared with specimens from the twelfth and thirteenth days. There is evidence of mild infection. Figure 6 is a photomicrograph from a section of similar histological appearance.

The changes in gland form which initiate the pregravid period are presented in Figure 7 which is a photograph of a free hand section. The glands have widened until the lumina are wider than one half the diameter of the glands. While some of them are almost straight (gl 1) most of them have become sinuous (gl 2) or symmetrically sacculated in form. In other parts of this mucous membrane and in other specimens the first appearance of wavy or irregular gland form is found in the basal one third (gl 3). Slender horizontal tubules arising from the bases of the glands branch extensively and there is some evidence of connections between tubules from adjacent glands. Two basal buds (BB) close to the surface and dilated with secretion were observed. Since mitosis was still active they would probably have reached the surface and not have become cystic glands.

CC 66 twenty first day. The mucous membrane is 3.0-4.5 millimeters thick. The gland epithelium is in the early stage of secretory activity. Mitotic activity is considerably diminished. Figure 8 is a photomicrograph of a free hand section illustrating the meandering course of a majority of the glands.

The next specimen cannot be regarded as normal but many of the glands were perfectly typical and can be used to illustrate the form of the pregravid gland.

CC 98 thirty ninth day. The epithelium is not in the typical pregravid phase of secretory activity but contains abundant glycogen. Mitotic activity is markedly diminished compared with the preceding specimens of the proliferative phase. The stroma is however oedematous and the histological picture is that of the early pregravid phase. Cystic glands are not infrequent and their presence may be regarded as an early stage of hyperplasia. The degree of infection is slight. It is included here because particularly good isolated glands were obtained.

Figure 9 shows several such entire glands isolated by acid maceration. Transitions are manifest from the slender round sinuous glands to the complex sacculated and folded ribbon like types. Gland 1 is a basal bud which had not reached the surface and was dilating due to accumulating secretion. Figure 10 shows a ribbon like gland photographed from two sides. Note the difference in appearance and the ease with which different interpretations of the same gland might be made depending on the plane of section in which it was cut.

*Late pregravid phase* CC 143 twenty third day. The mucous membrane is 2.8-4.2 millimeter thick. It is typical of the pregravid (Schroeder's secretory) stage (II, 11). The superficial stroma is somewhat oedematous and contains many enlarged cells of the decidual type. While there are many gland cells which are not actively secreting there are other which are at the height of the secretory activity typical of the pregravid phase. It presents a normal histological picture and agrees closely with our other pregravid specimens and also with Schroeder (1926) Figure 44 taken from the twenty sixth day. A normal corpus luteum in full bloom was obtained from this case.

In view of the descriptions of pregravid glands given by previous workers their form is surprisingly irregular. In occasional groups of glands the slender shape of the proliferative phase is retained and the only evidence of pregravid change in their form is a slight rugosity in the wall. In many there is a slender neck prophetic of the neck of the decidual gland opening into the uterine lumen.

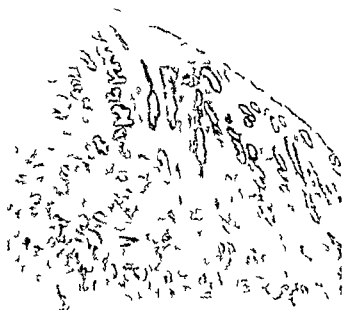


FIG. 6 CC 176 twenty first day. Photomicrograph of a  $6\mu$  section of a mucous membrane in the early pregravid phase. A stroma of organoid connective tissue, increased width of the glands and decreased mitotic activity characterize this stage  $\times 20$ .

tened much convoluted ribbons as the spongiosa is reached. We find all transitions from this condition to almost complete desquamation of the functional layer. This specimen also illustrates the necessity of making a complete survey of a menstruating endometrium rather than of studying a single block.

CC 93 second day. The mucous membrane is 0.5 to 1.0 millimeter thick. There is little or no evidence of secretory activity in the remaining portions of the glands and the gland lumina contain a scanty secretion and a few blood corpuscles. Occasional patches of epithelium in the late stage of secretory activity may be observed. There is abundant blood in the superficial area and lymphocytes are numerous. No mitoses were observed.

In the fundus the glands are simple cylindrical which divide as the lamina basalis is reached. Here there are isolated gland tubules near the tunica muscularis which we interpret as basal buds. Free glands may project for a considerable distance above the surface into the lumen of the uterus. In the region shown in Figure 17 part of the functional layer persists as is shown by the irregular form of the glands.

**Repair.** With the beginning of reepithelization the postmenstrual repair stage starts

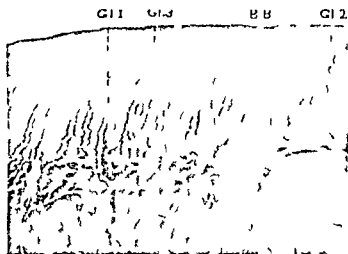


FIG. 7 CC 61 twentieth day. Photograph of a thick free hand section of a mucous membrane in the early pregravid phase. Beginning sinusity and alveolation in the base of the gland observed  $\times 15$ .

CC 161 fourth day. The mucous membrane is 0.5 to 0.8 millimeter thick. Histologically the lamina basalis which is all that remains of the mucous membrane is normal (Fig. 18). Slight evidence of blood extravasation remains and there is no lymphocytic or plasma cell infiltration. Many glands extend above the surface and occasionally they are bent over in contact with the adjacent stroma. In a few regions epithelization seems to have begun by the migration of epithelial cells from the mouths of the glands (Fig. 19) and in one instance a layer of surface epithelium connects the mouths of two glands—proof of beginning epithelization.



FIG. 8 CC 66 twenty first day. Photograph of a free hand section of an early pregravid mucous membrane in which the spiral type of gland is common  $\times 15$ .



Fig 3 CC 88 t lft h d y A f wh l gland l t d by d mace t o  
fr m a e l met um th ly p olif rati ph s A b l bud f m  
the b an hcd b al p u n f Glad I  $\times 9$

(Fig 15 seq) The opposite side gives little evidence of oncoming menstruation beyond the great congestion of blood in the vessels and the absence of secretory activity. The intervening region is transitional.

This specimen illustrates that menstrual denudation may occur by sequestration as well as by the gradual crumbling of the superficial zone as illustrated in the two preceding

specimens. It further shows that different areas of the same mucous membrane may at the same time present different stages of the menstrual process.

CC 101 second day. The mucous membrane is 0.6 to 2.8 millimeters thick. This is due to the fact that in the depth of the fundus the mucous membrane is still intact (Fig 16). Here we see a hæmorrhagic stratum compactum containing numerous decidual cells and traversed by the slender necks of the glands. The gland necks expand suddenly into flat

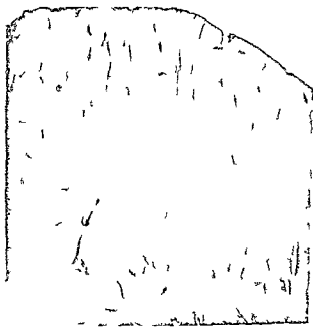


Fig 4 CC 05 t nth d y Ph t mco ph f m  
a 6 p s t n of an ndomet m n th l t p liferati  
pha e The stoma mo den e th n n the c ly phase  
and the glands app ar more numero s  $\times 2$

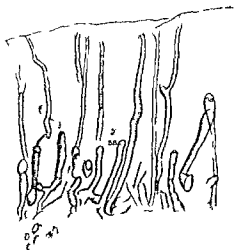
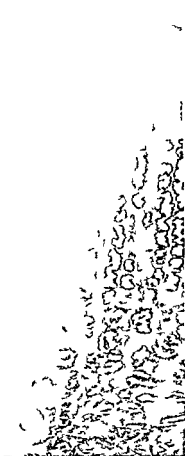


Fig 5 CC 4 fite th d y Lat pr liferati phase  
Th k f h d se t Th are n m bas b l  
so wh t d l t d with se t a d f n r ed l gth  
N t e n c ase m w d th a d l th f th gl d mpared  
with th a l y p oliferati phase (Fig 3)  $\times 19$



ntly third day. Photograph of a late pregravid mucous membrane in the c in the stroma the late stage of the lining division into a stratum compactum characterized by a mucous

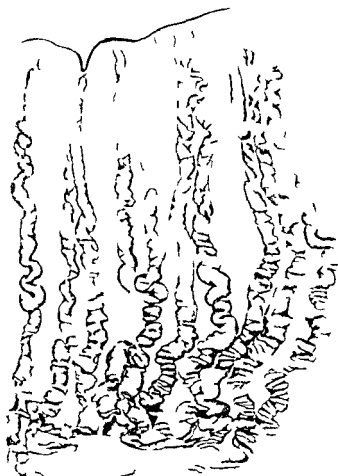


Fig. 1. CC 143, twenty third day. A group of glandular structures from a thick free hand section of the same endometrium as shown in Figure 11. Note the sinuous alveolated shape and slender necks opening into the uterine lumen.  $\times 19$ .

stage intermediate between figures 119 and 121.

This specimen is classified as approximately six and one half weeks of age. The embryo measures 160 millimeters in crown length. The decidua is 48 to 50 millimeters thick. Both histological and clinical sections show a resemblance between this specimen and H 951 described above. The stratum compactum now forming the middle half of the entire thickness of the mucous membrane is much wider and the necks of the glands which traverse it correspondingly more slender. The epithelium of the surface of the necks is low and atrophied. The decidua lacks a well defined lamina basalis.

#### DISCUSSION

The stage of repair consists in the epithelization of the wound surface by the conjunc-

tion of epithelial sheets which migrate from the mouths of the glands. As a result of the gradually increasing mitotic activity the slender simple glands of the period of proliferation are reconstituted.

Throughout the proliferative period the glands lengthen and the lumina widen. The rate of growth of the glands becomes more and more rapid as compared to the stroma and as a result the gland assumes a sinuous form. With the onset of secretory activity the individual gland cells increase in size adding still more to the gland surface.

During this time the number of glands may be increased by the growth of basal buds from the lamina basalis to the surface. It is possible that some of the basal buds may represent the remains of glands which did not join in the epithelization during repair period and so did not reach the surface. The majority take their origin from the bases of the glands.

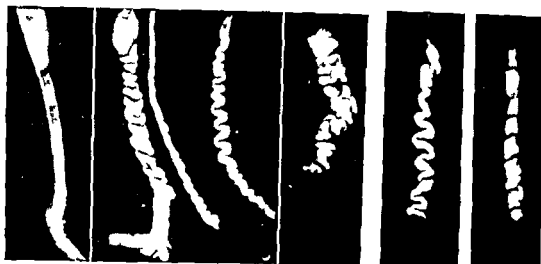


Fig 9

F

F 9 CC 98 th ty nu lav ft th beg nun f  
th l t p ol A r n t v f p g id gl l l t d  
f m t l mu u m m b ne of pat t h s e m tru l  
h t v ul G l nd i b l b d d l t e d th  
se r tion Gl d a b b n like type Gl a d 3

le d lightly mod f d typ th ru o e all Gl d 4  
a t e m typ of p gra d tr f m a t X 2  
F g CC 98 th ty day after th b g n n o f  
th l t p e d A n b b n like gl d photographed f a  
t v o s i d s C m p a th Gl d 2 F 9 X 2

*The decidua gland* If an ovum is implanted in the endometrium menstruation does not interrupt the process of pregravid change secretory activity continues in the gland epithelium stroma changes are accelerated in a striking fashion the stroma cells hypertrophying into the larger decidual cells and consequently the compact and spongy layers are more clearly differentiated. There are no sharp differences between the pregravid mucous membrane and the early decidua the pronounced decidual reaction for example is the only criterion by which a three week decidua in our collection may be considered more advanced than one of our non gravid 6 day specimens.

H 518 (estimated at 18 to 19 days by J P Greenhill 197) The decidua is 3.9 millimeters in thickness. Only an occasional gland is actively secreting the remainder of the epithelium is in a resting stage. This is probably due to conditions which brought about the abortion. Numerous blood sinuses and a few areas of extravasated blood appear in the superficial portion of the mucous membrane. A division into compact and spongy strata can be observed.

The gland are sparse and frequently slender with ridge like alveolations of the gland

walls which produce localized increases in their diameter. Not all of the alveolation are symmetrical they may appear as irregular ridges upon one surface. Since there are more common than the symmetrical alveoli sections through the glands have a markedly irregular appearance. They do not present the typical saw toothed condition in longitudinal section.

H 951 This specimen is a 3-4 weeks pregnancy with a 40 millimeter embryo. The decidua is 6.8 to 11.6 millimeters thick. The surface of the decidua vera is directed by irregular furrows. In the stratum compactum the gland appear as straight slender tubules .03 millimeter in diameter the epithelium of which is flattened and appear stretched. In the stratum spongiosum the gland widen suddenly and closely approximate each other. Their epithelium is in an advanced state of secretory activity. The outer wall of the gland in the stratum spongiosum are frequently smooth except for narrow irregular invaginations of stroma elements which form the cores of the saw teeth usually. Since other irregularities do not usually appear upon the surfaces of the gland it may be assumed that these were eliminated by the expansion and mutual compression of the glands.



FIG. 11 CC 143 twenty third day Photograph of a  $10\mu$  section from a late pregravid mucous membrane. Very few mitoses and these in the stroma the late stage of secretory activity and beginning differentiation into a stratum compactum and upon 10- $\mu$ m characterized this mucous membrane  $\times 20$

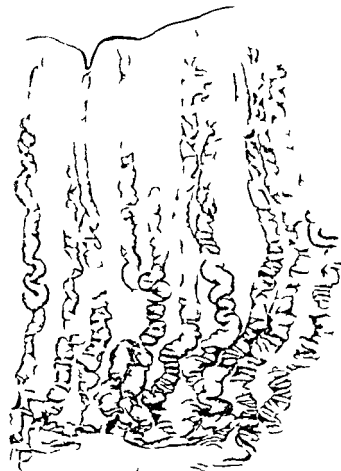


FIG. 12 CC 143 twenty third day A group of gland drawn from a thick free hand section of the same endometrium as shown in Figure 11. Note the sinuous alveolated shape and slender necks opening into the uterine lumen  $\times 19$

It presents a stage intermediate between Grosser's (1935) figures 119 and 121.

H 465 This specimen is classified as approximately six and one half weeks of age. The embryo measures 160 millimeters in crown rump length. The decidua is 4.8 to 9.0 millimeters thick. Both histological and thick sections show a resemblance between this specimen and H 951 described above. It unquestionably represents a more advanced stage. The stratum compactum now forming one half of the entire thickness of the mucous membrane is much wider and the necks of the glands which traverse it correspondingly more slender. The epithelium of the surface and of the necks is low and atrophied. The decidua lacks a well defined lamina basalis.

#### DISCUSSION

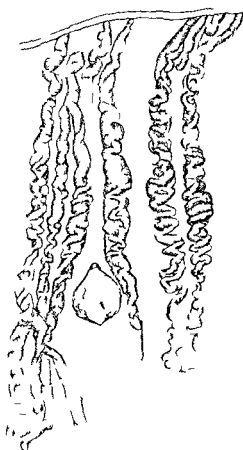
The stage of repair consists in the epithelialization of the wound surface by the conjunc-

tion of epithelial sheets which migrate from the mouths of the glands. As a result of the gradually increasing mitotic activity the slender simple glands of the period of proliferation are reconstituted.

Throughout the proliferative period the glands lengthen and the lumina widen. The rate of growth of the glands becomes more and more rapid as compared to the stroma and as a result the gland assume a sinuous form. With the onset of secretory activity the individual gland cells increase in size adding still more to the gland surface.

During this time the number of glands may be increased by the growth of basal buds from the lamina basalis to the surface. It is possible that some of the basal buds may represent the remains of glands which did not join in the epithelialization during repair period and so did not reach the surface the majority take their origin from the bases of the glands.





F 3 CC 69 tl tu d y G p f gland dr wn  
f a th kf i n l t n f mu u m mt th t  
h d h d t l l gl t f t l p gr l pl X 9

F 4 CC ya Th k f hand ct fr m th  
frst d f m t t n Th mucos m mbra h d  
f rg n ma k dp g dt n fo m to Th from  
h l ed a d g rg d t h blood th gla t  
f rly t t dp j t b v tle d s f th erot  
t m X 9

Since basal buds are to be observed in practically all specimens of the proliferative stage we are justified in believing that the number of glands is normally increased during the cycle. A comparison of photomicrographs of the eleventh and twenty-third day cases (Figs 1 and 11) makes this appear to be the case. This is however a difficult matter to decide. If we were to assume that the stroma remains stationary during the cycle it would be easy to show that the decrease in distance between the glands is simply a matter of their increase in diameter but this assumption is false because we know that the uterine mucous membrane doubles or triples in thickness during the pregravid period as compared to the period of repair and thus involves a material increase in the stroma. The stroma cells are separated by an accumulation of oedema

fluid. In order to prove then that the number of uterine glands increases during the cycle it would be necessary to determine the ratio between the stroma growth and increase in glandular surface. This could be done only by studying the statistics of many hundreds of normal cases. The alternative would be to count every gland in a large series of normal uteri with similar histories removed early and late in the cycle.

The gradual cessation of proliferative activity during the latter half of the cycle leaves some of the basal bud which may be very numerous (CC 141 Fig 5) stranded at a variable distance between the lumina basal and the surface. When pronounced secretory activity is inaugurated in the gland those buds which have not reached the surface are dilated for the only path by which the secretion could reach the lumen of the uterus is by way of gland tubules in the



Fig 15 CC 83 Photograph of a block of tissue in alcohol from the first day of menstruation. The mucous membrane shows different stages of the process. SEQ indicates an area in which sequestration is occurring. The opposite area is hyperemic while the transitional area is hyperemic and necrotic. Evidently it will next be affected by the menstrual process.  $\times 15$

lamina basalis. The peripheral dilatation of such basal buds shows that secretion does not follow such a course.

The uterine glands differ from most other glands of the body in their periodic intense proliferative activity. Their separation from



Fig 16 CC 101 Photograph of a thick free hand section from the second day of menstruation. An area of intact mucous membrane is shown which grades off to almost complete denudation illustrating that necrotic changes do not go on at the same rate throughout the endometrium.  $\times 20$

each other by an abundant stroma, their very delicate connective tissue sheath and their periods of heightened secretory activity. The combination of these factors naturally results in irregularities in the form of the glands, budding from the gland walls, union of buds from adjacent glands in the basal zone, and branching.

In their pregravid transmutation the changes which the glands undergo are purely fortuitous, being a combination of the circumstances of torsion, degree of secretory

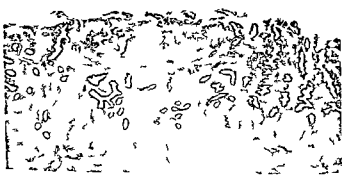


Fig 17 CC 93 A photomicrograph of an  $8\mu$  section from the second day of menstruation. Little remains besides the somewhat sinuous and alveolated basal portions of the gland in a zone of the functional layer overlying the lamina basalis.  $\times 20$



Fig 18 CC 161 fourth day. The stage of repair. Only the lamina basalis remains. At Y epithelial cells are migrating from the mouth of a gland to re-surface the mucous membrane.  $\times 60$

TABLE I—CLINICAL DATA ON THE SPECIMENS DESCRIBED

LCN	D <sub>3</sub> l f	U l f l gth f l d fll w	Age f p t t mb f g t	D <sub>2</sub> t m f	P b l g l d g o s	Spe t d d
8 (p l f)	3	8/	p	9 mos	Ut p fb my m bl z l l	C p f d
88 (p l )		8	s p	m	Py lp	F d
4 (p l f)	5	8/ 5	p	6 m	F b	Wh l t
(p l )		8	p	3 w k	Pl pe t	Wh l t
66 (p )			p	7 k	Pl pe	F d
98 (p g )	39	8 4 5	7 p	4	F b t l	C p l l
3 (p gr )		?	9 p	6 k	Pl px	Wh l
69 (p b )		8	3 p		F b	Wh l
(m )		8	4 p	?	Pl pe t	C p f d
7 (m )		8	7	y	Ib d	C p f d
83 (m )		8	5 p	6 mos	Ib d	Wh l t
9 (m )		/		ks	fb m m lp	C p f d
(m )		/			Pl p t	Wh l
6 (m no )		8 4	5 p	y	Ib l	C p f d
H 58 (de )	i c f k	?		?	Abu	E dec d
H 95 (d )	f l k	t	?	?	F b my m	Wh l
H 65 (d )	?	t	?	?	F b my m	Wh l t

activity differences in the rate of growth between epithelial and stroma elements and pattern of the investing blood capillaries these factors may vary in their effect and as a result the eventual form of the gland varies. Symmetrical spiral glands such as have frequently been described from study of thin sections are rather uncommon in our material.

In Figures 11 and 13 taken from pre-gravid mucous membranes there are suggestions of slender necks interposed between the convoluted portion of the glands and the surface and traversing the compact layer. These slender necks are the forerunners of the elongated necks of the decidual gland which are lengthened after the implantation of the ovum as a result of the hypertrophy

of the decidual cells in the development of the stratum compactum. Such a process of hypertrophy increases the thickness of the compacta and so the epithelium of the gland adjoining the surface is stretched out and the diameter of the lumen decreased.

Secretory activity is accelerated in the decidual gland and as the outlet perhaps restricted secretion accumulates to a greater extent than before. The glands come into contact with one another and the external irregularities are more or less smoothed out by mutual pressure. The original folding of the wall nevertheless persists as serrations projecting into the lumen. Thus we have the saw-tooth pregnancy gland to which Opitz called attention in 1899.

## SUMMARY

During the period of proliferation the uterine gland is characterized by its slender cylindrical shape with a lumen less than one half the diameter of the gland. Usually the lumen is somewhat greater basally but even at this stage irregularities are encountered.

The simple tubular glands may end in slight dilatations at the base of the mucous membrane or they may divide at any point in their course but this is uncommon except in the lamina basalis. Rarely we see two glands unite and the single trunk extend to the tunica muscularis. In the basal zone branches of the second or third order may be found and they may follow a course parallel to the muscle layer. These ultimate branches are slender tubes sometimes of considerable length. In this proliferative stage basal buds are observed appearing first in the basal portion of the functional layer and projecting toward the surface. The later the stage in the cycle the longer the buds usually are.

As growth progresses increase in width of the glands occurs. bifurcated glands are more common and undulations or symmetrical alveolations appear first in the basal part of the functional layer and gradually extend throughout the glands. Further changes are fortuitous and the final shape assumed by the pregravid gland is variable depending upon secretory activity and differences in growth between the stroma and gland epithelium. These glands may be circular or oval in cross section and follow a spiral or undulated course with occasional buckling of adjacent limbs upon one another at different angles. In many mucous membranes an undulated ribbon like gland predominates. A few glands even in the most pronounced pregravid mucous membranes remain slender and unchanged save for a slight rugosity of their walls. The tubules of the lamina basalis usually remain unchanged.

During the necrosis accompanying menstruation the glands are more resistant to this necrotic process than is the stroma and as the necrosis progresses the glands can always be observed protruding above the level of the stroma.

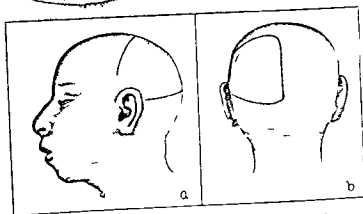
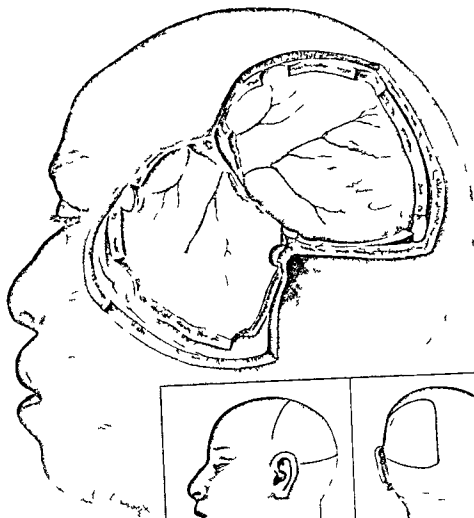
In repair epithelialization occurs by migration of the epithelial cells from the mouths of the glands and this process is aided by the tendency of the projecting glands to bend over upon the denuded surface. Mitotic activity begins at once immediately causing changes in the mucous membrane.

The typical decidural gland is characterized by two features: (1) a long slender neck traversing the stratum compactum and (2) an almost smooth exterior in the stratum spongiosum which has resulted from pressure and dilatation. The original irregularities persist as projections into the lumen.

Acknowledgment is due Dr. Geo. W. Bartelmez under whose supervision the present problem has been undertaken for many of the illustrations included for criticism in revision of manuscript and for constant encouragement. We are also indebted to Miss Agnes Nixon for the drawings which accompany the text and to Miss C. M. Bensley for aid in the preparation of material.

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f m b f b c k d

*Brain Surgery—Head and Cervical*

# CLINICAL SURGERY

FROM THE DIVISION OF NEUROLOGICAL SURGERY UNIVERSITY OF CALIFORNIA

## BRAIN SURGERY

WITH SPECIAL REFERENCE TO EXPOSURE OF THE BRAIN STEM AND POSTERIOR FOSSA THE PRINCIPLE OF INTRACRANIAL DECOMPRESSION AND THE RELIEF OF IMPACTIONS IN THE POSTERIOR FOSSA

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THE fascination of brain surgery lies in its difficulties. More than in the surgery of other parts the mere opening and closure of a wound is a major procedure. It involves a difficult approach through exceptionally heavy and resistant structures to organs vital, delicate and readily traumatized. It is laborious, time consuming, detailed work with constant possibilities for hemorrhage. The surgical treatment of the lesion itself often involves less time and effort than the exposure of it and the closure of the wound. The vascularity of the coverings and the special technical methods required to open the skull without injury to its contents both present their problems and their risks. For the future of the patient proper closure is of the highest importance. On the surgeon it makes special demands. The slow, painstaking, detailed closure at the conclusion of a trying operation demands a self-exacting thoroughness not often called upon in other situations. More rapid but less detailed methods of repair bring in their train late hemorrhage, herniations, brain damage, fungi and hideous harmful protrusions and scars. Training in this branch of surgery necessitates a degree of gentleness and attention to detail seldom acquired in the surgery of less delicate structures. Special methods are demanded for the control of bleeding and much experience in avoiding it. The elaboration of the technique of neurological surgery is evidence of the necessities though simplification of technique is always desirable.

Since the days of Lister the osteoplastic bone flap of Wagner with its wide exposure has replaced the measurements of cranial topography and the selection of a much debated localizing point for a trephine opening. Likewise craniectomies have given way to plastic operations upon the skull except in the subtemporal and sub-

occipital regions. In these areas where other structures than bone may give adequate protection to the brain such openings have their especial decompressive advantages. The temporal and cervical muscles act as protective coverings and at the same time restrain excessive or harmful herniations. Brain herniation through properly placed decompressions will cause no disabling symptoms. Operative procedures tend to become standardized. While for decompressions and approaches to near-by structures these craniectomies have especial advantages, the plastic operations are generally used for the cranial vault.

For operations upon the hemispheres—the parietal, frontoparietal and frontal osteoplastic flaps are used. All have their bases in the temporal region. With the thin squamous portion of the temporal bone in this location they break back readily. The temporal muscle and fascia act as a hinge. With the flap reflected removal of that portion of the bone beneath the temporal muscle permits leaving a decompressive opening after the flap has been replaced. These large flaps permit of wide exposure. Elevation of the frontal and temporal lobes gives access to the structures of the chiasmal region. The entire anterior fossa and the anterior portions of the middle fossa can be reached.

Less systematic attention has been given to surgical approaches to those structures in front of the cerebellum and between it and the third ventricle. This portion of the brain stem, the pons, tentorium and pineal region has received little notice. The surgery of this area involves special considerations. The principle of decompression to permit expansion outside of the cranial cavity is old. Yet within a certain part of the cranial cavity impactions occur.

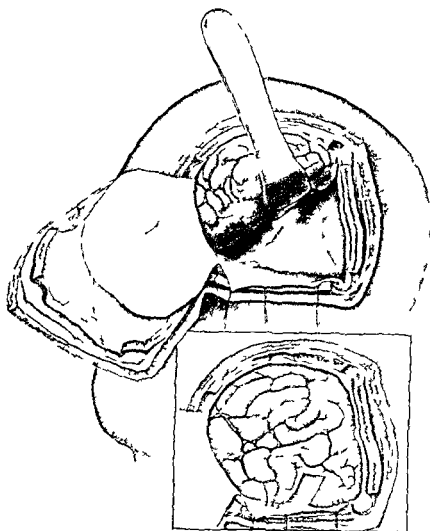


Fig. 1. The diagram illustrates the surgical approach to the posterior fossa, showing the tumor and the incision site.

Decompression of the lower portion of the occipital bone does not always relieve the pressure even when due to tumors in the posterior fossa. Persistent blockage of the peripontine pathways may persist. Enlargement of the posterior table below by suboccipital craniectomy is often disappointing for the reason.

The subtentorial space may be enlarged by wide opening of the tentorium or by section of the tentorium including the inferior tentorium. The approach is best made from above through what we have termed the occipital flap. The field of usefulness of this operation has widened in that it also serves as a supratentorial approach to certain infratentorial tumors. It permits access

to the posterior table tumors which spring from the tentorium and the posterior half of the falx, the entire occipital lobe and all the milline structure. Really exposure of the upper and anterior surfaces of the cerebellum is made possible which cannot be uncovered by a suboccipital operation. Enlargement of the posterior table gives added opportunity for expansion upward. The brain tentorium no longer impedes the foramen magnum. Expansion upward elevation of large masses beneath the occipital lobe gives no symptoms and the blockage of peripontine fluid pathways with hydrocephalus is relieved. Impaction of the brain at the inferior tentorium demands unusual method to procure relief from pressure.

## PREPARATION OF THE FIELD OF OPERATION

Shaving of the scalp is invariably performed on the morning of operation. Earlier shaving particularly if not carefully done may cause irritation or slight scratches may form ideal nesting places for staphylococci. Careful shaving is an important step in the mechanical cleaning of the scalp. When combined with equally detoured scrubbing with soap water and alcohol the use of other antiseptics can be left to the whim of the operator. Careless and rough scrubbing causing minute abrasions of the scalp is to be avoided.

## AN ESTHETICS

In this country while ether is the most favored anesthetic local anesthetics are being used more and more in the surgery of the central nervous system. In our experience ether has been highly satisfactory. Long periods of anesthesia are common. It is our impression that when properly administered little difficulty can be justly laid to the ether anesthesia. It is noteworthy that postoperative pneumonias are more rare after it in neurosurgical cases than in other types of surgery as reported by Cutler and Hunt (1) from the Peter Bent Brigham Hospital and by Terry (2) from University of California Hospital. It is our impression that children stand long periods of ether less well than adults. Even in the longest operations on adults other more likely causes could always be found if the condition of the patient was poor. Cranial operations are in many ways well adapted to the use of local anesthetics. Only the structures external to the skull need to be anesthetized. While the sound and feeling of the work on bone is unpleasant and may be startling when bone is fractured it is not painful. Likewise ordinary handling and cutting of the dura is without sensation. The brain is of course insensitive.

Bleeding is lessened by the injection of a local anesthetic with or without adrenalin as contrasted with the fact that there is apt to be increased congestion with ether. Wound healing in our experience has been equally good with both. It is not an uncommon experience to find that advocates of local anesthesia use considerable amounts of drugs having general effects particularly morphine and scopolamine. This is hardly local anesthesia and certainly such drugs in individuals prone to respiratory difficulties from pressure should be used guardedly if at all. In our own experience  $\frac{1}{2}$  to 1 per cent novocaine with 3 drops of 1:1000 adrenalin to the ounce has been used for infiltrating the scalp and for the deeper injections between pericranium galea

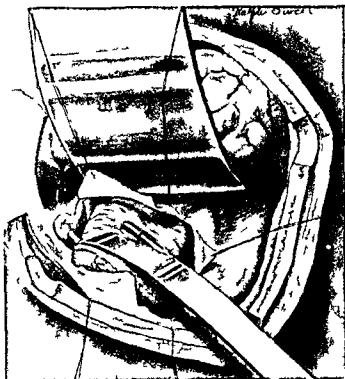
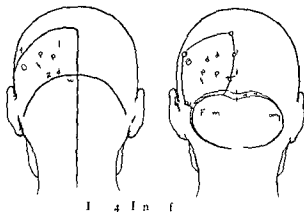


FIG. 3 The cerebellum and nerves from the base of the brain are exposed after incision of the tentorium.

and scalp. Lessened tendency to scalp bleeding occurs but another important factor in lessening bleeding is the use of a position in which the head is higher than the body though not necessarily a sitting position. In the event of respiratory difficulties it is desirable to be able to lower the patient's head.

As to the choice of anesthetic in an individual case. While judgment changes from time to time it is our custom to consider local anesthesia preferable in stuporous patients especially in those with respiratory difficulties or very high degrees of pressure and in others who may themselves prefer it. Likewise it is favored in patients with marked cardiorenal disease or pulmonary infections. The mere fact that an operation can be carried through with little or no pain under a local anesthetic is not to our mind a sufficient reason for invariably insisting upon it. If in such a case the patient is sweating or exhausted and worn out at its conclusion one can hardly feel it is altogether satisfactory. It requires a considerable degree of equanimity and fortitude for a patient unfamiliar with his surroundings to submit to a brain operation under local anesthesia. In special instances a light general anesthetic has been used for the latter portions of long operations. For the use of ether the intrapharyngeal method has met all requirements.





I 4 I n f

## THE GENERAL TECHNIQUE OF OSTEOPLASTIC FLAPS

Selection of the site of incision taking into account the area to be explored and leaving an adequate pedicle for the flap circulation and marking of the site should precede a firm draping of the field. Cross hatching of the line of proposed incision will facilitate proper matching of the margins upon closure. Digital pressure of assistants on each side of the incision is used to control bleeding and retract the margins of the wound while straight fine pointed haemostats are applied to the fibrous under layer of the scalp at frequent intervals usually about 1 centimeters. As these clamps are laid back the vessels of the scalp though they may not be included in the bite of the clamp are compressed. The scalp of the flap itself may be controlled in the same way or its base may be constricted by means of a special clamp.

For primary bone openings a broad perforator the point of which will pass through to the dura while the broad portion is still engaged is safe.

If the operator is careful to test bone thickness by percussion he will avoid possible accidents when dealing with the paper thin areas occasionally met. In placing the perforator openings it will be found that it is desirable to have the base of the bone flap near its hinge narrower than the free margin. If the two perforator openings nearest the base are placed to keep this in mind the flap when replaced will lie in position more satisfactorily. Five perforator openings in all are usually sufficient. The perforator opening may be enlarged with a burr of the same size. Motor driven instruments are preferred by some but add greatly to the armamentarium and to sterilization none to the safety and save but little time. With properly sharpened instruments the effort of making the openings is slight. Larger burrs are required to bevel the openings properly when the bone is unusually thick. Narrow long curved

periosteal separators are used to separate the dura from the bone prior to passage of guides for Gigli saws. With them the dura should be freed for the entire distance between opening. Two thin ribbon guides of spring steel with blunt points may be passed between adjacent openings. To a hook on one of these next the bone the Gigli saw is attached and drawn through. The second guide lies against the dura and protects it from the saw. With the Gigli saw the bone is cut from within out and beveled outward. It is well not to incise the galea and pericranium deliberately prior to this stage as if done it will be found that venous oozing from bone will occur and there is also a greater tendency for the soft tissues to strip from the bone of the flap. It is desirable to use fairly fine rather than coarse saws for though the latter cut faster they permit the flap to settle unduly when it is replaced. The base of the flap may be fractured back but when the bone is heavy as in the occipital flap it may require special cutting with saw or bone cutting forceps. Bleeding from the bone is controlled by the use of bone wax.

Reflection of the bone flap may reveal bleeding bone margins or bleeding from dural vessels. Temporary control of the latter by small wet cotton sponges and pressure will usually permit of the opening of the dura when they can be more safely controlled by suture or the use of wire clips. Prior to the opening of the dura the reduction of intracranial pressure is often necessary to prevent sudden herniation and brain contusion. This is readily accomplished in the presence of a hydrocephalus by ventricular puncture. Even in its absence some fluid may be obtained by ventricular puncture or hypertonic intravenous solutions of glucose or Singer's solution may be used. Occasionally puncture of the opposite ventricle through a separate opening is necessary. In our experience the dura is best opened by a flap incision with the base of the flap toward the longitudinal sinus. This permits of easier closure in the face of considerable pressure. The site and character of the lesion with which we are dealing often make some other arrangement of the flap advisable.

For the control of cortical vessels about a tumor ties with fine silk and silver clips are used. Haemostats cannot be used and tie are passed beneath the vessel with a blunt fine curved needle. During intracranial work and especially in surgery of the brain itself irrigation with Ringer's solution at 40 degrees C. largely replaces sponging and serves to keep exposed surfaces from drying. Moist cotton is also used

for small pressure packs. No gauze or other rough contact is permitted. Suction apparatus to which draw fluid from cavities and largely to replace sponging may be used with satisfaction. Small dural vessels may be controlled in the same manner or plastered with bits of muscle when tying or clipping is not feasible. For closure we believe that except over the area of a purposeful decompression the dura should be closed. Areas of dural defect in the absence of cause for pressure may however be permitted in certain instances. In the presence of pressure dural defects or dural and bone defects should not be left over the cerebral hemispheres except perhaps in a few instances of inoperable tumor already causing complete loss of function of that part of the brain.

For dural closure as for closure of the deep scalp and skin trials of many materials and many types of sutures have caused a return to the fine silk suture. Closely spaced sutures in the deep layer of the scalp best control bleeding. Ties of scalp vessels are rarely necessary and when used a suture is whipped about the vessel and then tied.

#### THE OCCIPITAL FLAP

The following procedure was first used in 1911 to gain access to an acoustic neuroma which had been found at an earlier suboccipital operation to be too high in the angle for a satisfactory approach by that route. Since that time this operation has been used with increasing satisfaction for a wide variety of lesions.

The occipital flap provides a supratentorial approach to infratentorial lesions. With tumors and with impactions in the posterior fossa it offers a method of intracranial decompression.

The occipital flap is placed with the hinge just above the mastoid and the posterior part of the temporal fossa. The anterior margin of the flap extends from the posterior part of the temporal fossa upward to the region of the longitudinal sinus and usually in front of the parietal eminence. The posterior margin is parallel to and immediately above the lateral sinus. The mesial margin of the flap is parallel to the longitudinal sinus and close to it. The patient is placed in the face down, cerebellar position; the flap fashioned in the usual manner except that the hinge of the flap should be saved as are the other margins. The thickness of the bone at the hinge is great enough to make the fracturing of it difficult and uncertain. With the dura exposed, ventricular puncture is performed and the ventricles well emptied. Nearly all of the lesions for which this operation is performed are associated with an internal hydrocephalus. The

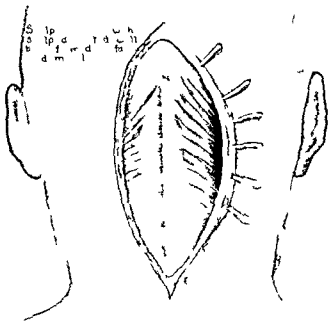
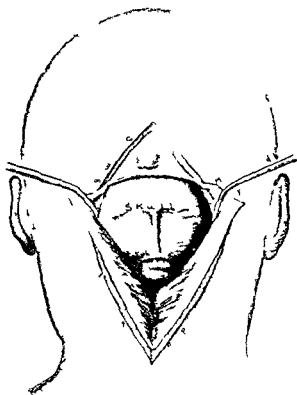


Fig. 5

emptying of the ventricle permits of easy elevation of the occipital lobe and wide exposure (Fig. 2).

The dura is opened usually with the hinge anteriorly. A varying number of veins will be found communicating with the lateral sinus from the margin of the occipital lobe. These are clipped or tied and divided. From the dura over the petrous bone in the region of the internal ear two or three veins from the temporal lobe may likewise need ligating. The occipital lobe if the ventricles are well emptied is then elevated with a broad flat spatula or broad lighted retractor. The lifting of the occipital lobe upward exposes the tentorium, the attachment to the margin of the petrous bone, the floor of the middle fossa and far forward to the posterior clinoids. Retraction of the lobe laterally from the falx exposes all the posterior portion of the falx, the entire half of the tentorium and up to the corpus callosum, the pineal region and the incisura tentorii. The sinus rectus, lateral and longitudinal sinuses are of course all visible. No other flaps in ordinary use give as wide a range of exposure as does the occipital flap.



F 6

For approach to the infratentorial lesions if pressure in the posterior fossa is high even after the reduction of supratentorial pressure by the ventricular puncture a lumbar puncture may be performed.

*Incision is made in the tentorium.* Occasionally irregular venous sinuses may be seen in the tentorium but can be controlled. The incision in the tentorium is widened in all directions up to the petrous bone anteriorly to the sinus rectus mesially and to the lateral sinus. An occasional vein bridges between tentorium and cerebellum and requires clipping. With this opening the upper surface of the cerebellar lobe is exposed over a wide area (Fig. 3). Retraction of it backward and laterally give an exposure of the angle and the pons. The seventh and eighth nerves are seen below and the fifth root toward the midline. Beneath the apex of the tent may be seen the opposite cerebellar lobe.

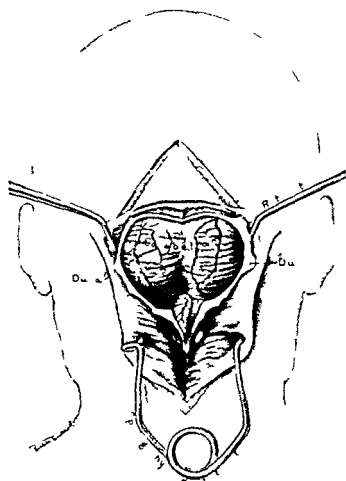
In the use of this method less dislocation of the cerebellar hemispheres and brain stem is required to secure a high approach to the angle. The pons may be seen and dissection conducted away from it rather than toward it as in the case from a crossbow incision.

With invading tumors the large tentorial opening which is not closed permits an intracranial decompression of the posterior fossa with relief of the impaction is often seen. Following a suboccipital operation for an irremovable tumor the internal hydrocephalus and increased pressure may persist due to unrelieved block. In such instances the tumor together with the other structures of the posterior fossa so fill the space that an impaction persists. Blockade of the fluid channels about the incisura tentorii—the peripontine pathway and the midsagittal cerebellar channel or the posterior part of the intraventricular system persists. Wide opening of the tentorium permits upward expansion of tumors which otherwise press the cerebellum downward and enlarges the subtentorial space. Protrusion or extension upward beneath the occipital lobe is accompanied by no symptoms and great expansion is permitted. With great dislocation of structures in the posterior fossa the incisura tentorii may be cut.

This has resulted in the relief of obstructive hydrocephalus when suboccipital decompressions have failed. At the conclusion of the operation the dura of the tentorium is left widely open. The dura over the vault is completely closed and the flap replaced.

#### MODIFICATIONS OF METHOD

In individuals who have previously been subjected to a suboccipital operation the occipital flap may be modified. If there has been a suboccipital crossbow incision one lateral half of the incision may be used to form the posterior margin of the occipital flap (Fig. 4). In such instances the scalp has been dissected downward sufficiently to expose the line of previous incision in the neck muscles just below the superior curved line. The muscles have been cut again along the line of previous incision. The occipital flap has been then formed to include all the bone down to the decompressed area. This involves removal of the bone overlying the lateral sinus but this has proved to be surprisingly free from difficulty. The bone cuts are made in such a way that the flap cannot slide downward due to pull of the neck muscles after closure. In certain instances to secure even greater freedom of exposure the lateral sinus may be tied and divided. The cut may be carried on to the incisura and the entire tentorium reflected. Inasmuch as the suboccipital operation has been previously performed the cerebellum is already decompressed and can be retracted posteriorly and downward much more readily.



F1

# MODIFICATIONS OF SUBOCCIPITAL PROCEDURES

The crossbow incision of Cushing may with certain lesions and depending upon the build of the individual patient be modified to advantage. In the midline tumors of children in intra cerebellar tumors and especially in those adults with long necks a midline incision has been used. In the presence of intracranial pressure the bleeding is lessened during the operative performance by an early reduction of pressure. With an internal hydrocephalus early ventricular puncture through a separate small opening over the posterior horn of one lateral ventricle is helpful. This should be performed at the beginning of the operation. Pressure is at once reduced bleeding lessened and the presence of an internal hydrocephalus confirmed—the absence of which would indicate a probable diagnostic error and unnecessary suboccipital operation. Certain technical points should be observed to obtain the best exposure. The midline incision should extend from about 4 centimeters above the external occipital protuberance downward to the fifth

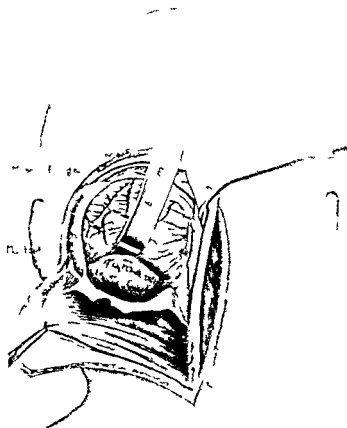


Fig 8

cervical spine or lower and is carried through the scalp down to the deep fascia (Fig 5). Wide dissection of this layer from the deep fascia is important and the separation is carried well lateralward. The midline between the cervical muscles is split, retracted, and subperiosteal separation of muscles from the occipital bone is made. This is facilitated by the use of double angled elevating retractors. The subperiosteal separation is carried from the muscle attachment at the superior curved line above to the mastoids laterally and temporary gauze packs introduced. After a similar separation on the opposite side the area of exposure is increased by cutting the deep fascia and muscular attachments to the right and left of the torcula for a distance of about 3 to 4 centimeters. A fringe of deep fascia and muscle is left for subsequent suture (Fig 6). Contrary to the crossbow incision in which the occipital artery and great occipital nerves are divided these structures can be spared. The nicking of the firm ligamentous attachments to the foramen magnum and the atlas and the use of spring thyroid retractors give a wide exposure and permit the same bone removal, dural opening and opportunity for decompression and the necessary intracranial work as the wider cross

bow incision (Fig 7) Closure of course is much simplified

#### THE APPROACH TO TUMORS OF THE CEREBELLO PONTILE ANGLE BY THE SUBOCCIPITAL ROUTE

With angle tumors if approached from below a combination of the above midline incision with a single half of the crossbow incision shortens the procedure considerably without sacrificing the advantages of the full crossbow (Fig 8) The side opposite the lesion can be fully decompressed without wide incision of scalp and muscles On the side of the lesion the curved incision should be carried out to the mastoid and down to or just below its tip To obtain the full advantages of exposure the scalp must be freely dissected well back from the deep fascia before cutting the muscular attachments at the curved line The bone removal must extend fully to the lateral sinus above and laterally to and often into the mastoid cells The bone removal below is carried well beneath the reflected muscles which are thoroughly retracted

In the crossbow operation of Cushing improper handling during and after operation may give rise to two difficulties Impairment of circulation of the angles of the flaps is caused first by too free use of hæmostats in this region throughout the operation and second by deep sutures of the scalp which include and constrict too much tissue and skin sutures which bear the same criticism During the closure for a distance of 2 centimeters from the angles fine skin sutures which take very small bites of the skin only without subcutaneous tissue are sufficient to ob-

tain accurate approximation The full crossbow incision divides the entire occipital nerve supply leaving the most prominent portion of the occiput anæsthetic The risk of decubitus if the weight of the head is allowed to rest indefinitely on this area is obvious particularly since its blood supply is somewhat lessened by the same incision The proper tilting up of the suboccipital hollow with an adequate amount of dressings will remove the possibility of too localized pressure and the unnecessary decubitus

As in the surgery of other regions a satisfactory exposure of the lesion is essential For many of the lesions in the posterior fossa the crossbow incision of Cushing or some of the simplifications of it are satisfactory For the approach to lesions high in the angle it leaves much to be desired The methods here presented have been found helpful By means of the occipital flap a trans tentorial approach can be made It affords access to the upper and anterior surfaces of the cerebellum to the fifth nerve and other nerves of the angle This is an ideal approach for lesions of the tentorium the posterior half of the falx cerebri the occipital lobe the pons and pineal region Section of the tentorium and incisura tentorii affords a method of intracranial decompression By means of it hydrocephalus from impaction in the posterior fossa has been relieved when other measures have failed

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FROM THE SURGICAL SERVICE OF RUDOLF HOSPITAL OF VIENNA I

## THE THORACOPLASTIC TREATMENT OF PULMONARY TUBERCULOSIS

BY PROFESSOR WOLFGANG DIENK VIENNA AUSTRIA  
D i e t h i s g i s R i e h p a l

THE operative treatment of pulmonary tuberculosis not only is of advantage to the individual but possesses great hygienic importance for society because in the great majority of cases it is possible to free the sputum of the patient from bacilli and thus eradicate one more source of infection in the patient's environment. The surgical treatment of pulmonary tuberculosis is therefore of no little importance and deserves to become better known.

If the outcome of operation is to be good the indication for operation must be right. This however is a problem as difficult to solve as it is important. In principle only unilateral cases are suitable for surgical treatment if internal measures have proved fruitless or the financial status of the patient makes protracted conservative treatment impossible. Old stationary individual foci in the healthy lung form no absolute contra-indication but one must make sure that such foci have no tendency to progression. In addition the diseased lung must disclose a tendency to shrinkage (purely or predominantly productive or proliferative type of tuberculosis). Essentially exudative forms which lead to rapid progression of the disease and cachexia are much less suitable for surgical treatment since the chances for cure or considerable improvement are small and the mortality is great. The one other requirement for operation is the presence of pleural adhesions since the presence of a normal pleural cavity demands the trial of an artificial pneumothorax. It is important to try such a pneumothorax before deciding upon operation. I have repeatedly observed that pneumothorax is still possible in cases in which the pleural cavity is apparently entirely destroyed. Only in exceptional cases should primary thoracoplasty be tried with the presence of a free pleural cavity. Aside from an extensive affection of the other lung absolute contra-indications to thoracoplastic treatment are high fever, rapid progression of the case, lobar tuberculous pneumonia, decompensated cardiac affection, tuberculosis of the intestines and kidneys, and multiple foci of the bones.

Partial thoracoplasty is indicated in cases of incomplete pneumothorax or as a complement to the non-collapsed part of the lung in the presence of a lung plug.

Of the various methods of operation in use I wish to discuss only that of thoracoplasty.

## TECHNIQUE

*Preparation of the patient.* Every protracted case of pulmonary tuberculosis damages the heart because of toxic action and the result is to be observed in tachycardia and an easily compressible pulse. Since thoracoplasty calls for reliable heart action because of the reduced pulmonary circulation on the side operated upon it is necessary to carry out a preliminary treatment if the heart is not in satisfactory condition. This is done by the administration of digitalis or cardiazol as well as by keeping the patient in bed. It is especially important to cleanse the affected pulmonary focus as well as possible by means of expectorants so that postoperative stasis of secretions and the danger of aspiration may be avoided. The intestine should also be cleansed in order to save the patient the strain of exhausting enemata following the operation. A half hour before operation the patient receives 0.01 to 0.02 gram of morphine and  $\frac{1}{2}$  milligram of atropine hypodermically.

The position of the patient on the operating table is of especial importance. Inasmuch as the operation is if possible to be done under local anaesthesia the patient should be placed as comfortably as possible. The back of the table is raised upright and a round pillow is placed in the lumbar region of the patient. In this way the spinal column of the patient is bent toward the healthy side; the affected side is maximally curved; the intercostal spaces broadened and the operation thus considerably simplified. A pillow is also placed under the head of the patient after it has been bent forward. The arm of the healthy side should not be placed on the pillow under the head but is held down since otherwise quite unpleasant paresthesia occurs (Fig. 1). An assistant extends the arm of the affected side maximally toward the front and downward in order to draw the scapula away from the ribs. A pillow fastened close to the patient's pelvis on the table prevents the patient from slipping down. The patient's feet hang over the edge of the table, but they must be well supported by a chair. The assistant who pulls on the arm of the affected side simultane-

ously pre-vents one from falling over forward.

*Incision.*—The thoracoplasty operation can almost always be done under local anesthesia and only if the patient is very restless and nervous it necessitates the use of a short and superficial ether narcosis. I consider that a general anesthetic is detrimental and I have never yet had to make use of one in these cases. The method of choice is carbon tetrachloride anesthesia of the intercostal nerves. After the field of operation has been disinfected 10 cubic centimeters of a 1 per cent solution of novocain or of a 4 per cent solution of tetracaine are injected at the lower edge of the rib in question about three fingers' breadth lateral to the medial line of the spinal processes. This injection is made on every rib to be resected in addition to which the line of incision is infiltrated in all 3 layers: intra-utaneous, subcutaneous and intra-muscular.

If the patient is lean intercostal anesthesia by this method is rather easy. If the patient is very muscular or fat it is often impossible to palpate the point of injection on each rib and this is often impossible as far as the *more proximal ribs* are concerned as they are covered with thick layers of muscle. In such patients it is advisable to use some other method. One first anesthetizes the line of incision layer for layer with the anesthetic. Then each rib is exposed and the anesthetic applied directly. One should not inject more than a total of 150 cubic centimeters of the anesthetic. In 10 or 20 minutes the anesthesia is complete. Should pain occur during the resection it is necessary to apply a few more cubic centimeters of the anesthetic by injection on the upper and lower edges of the rib in order to free the patient from pain. Superficial general narcosis was necessary in only the most exceptional cases.

*Incision.*—Although the operation at one sitting is to be preferred to the thoracoplasty done in two or more sittings the operation is nevertheless as seldom possible at one sitting since it is too great an ordeal for an organism damaged to such an extent. Operations at one sitting will therefore be an exception to be carried out only in a very strong afebrile patient whose heart is in absolutely good condition in whom the tuberculous has been of the purely productive form with a tendency to shrinkage.

Generally the operation is carried out in two stages. In the first stage the eleventh to the sixth rib are resected in the second stage the fifth to the first. The section should begin over the upper rib only in the event of a tuberculous empyema which compresses the lower lobe of the lung.

Figure 1 demonstrates the incisions for each stage. The lower plastic is begun with an incision at a level with the sixth rib about five fingers' breadth lateral to the medial line of the spinal processes. The incision drops perpendicularly to the eleventh rib and then about a hand's breadth laterally along the eleventh rib. For the upper plastic the incision begins at about 3 or 4 fingers' breadth under the shoulder extends first between the medial furrow line and the medial scapular margin downward and as far as the scapular angle and then laterally until just under the latter. The incision should not reach the apex of the shoulder because this would cut muscle tissue unnecessarily and in addition provoke muscular atrophy by severing the branches of the transverse scapular artery. This result is not only disfiguring but also inhibits the function of the arm. An arch-like incision around the scapula easily permits the latter to be lifted away from the thorax thus offering a broader approach to the ribs just under it.

The incision should penetrate the skin, the subcutaneous tissues and also all the muscles as far as the ribs in the same direction. The soft flap thus formed is pulled away laterally as far as possible from the bones of the thorax. This is of especial importance in the scapular region. The long muscles of the back are separated from the bones and drawn toward the spine thus exposing the portions of the ribs between the costal angles and the lateral spinal processes. It is usually possible to secure hemostasis in the part by suitable compression. It is very important to treat these long muscles with consideration since they are the foundation of the upright posture of the spinal column and any considerable damage of them will enhance the tendency to collapse following thoracoplasty. No rib are free for resection. The periosteum in the middle of the ribs is first split and then with the rasp pushed away toward both edges. In order to expose the anterior surface of the ribs the edges must be absolutely free from periosteum. This is best insured by using the rasp from the median line outward on the upper edge and from the side toward the inside on the lower edge (i.e. against the direction of the fibers of the intercostal muscles). It is as soon as the posterior surface of the rib has been exposed the detachment of the periosteum from the anterior surface is carried out by means of a curved rasp (Fig. 3).

The effect of the operation is considerably improved if the ribs are extensively resected. The greater the destruction, the less the lung, the greater must be the extent of the resection and the collateral effect. The length of the pieces resected is

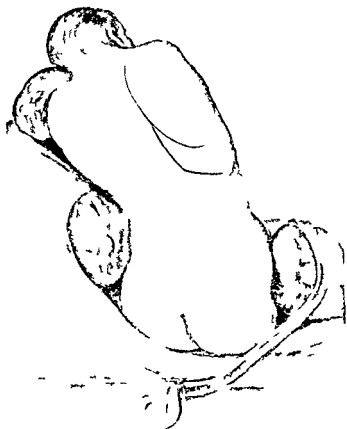


Fig. 1. Showing position of the patient on the operating table and incision lines for first (a) and second (b) stages.

determines the degree of collapse. In general 10 to 15 centimeters are resected from the lower ribs 10 to 12 centimeters from the middle ones and 4 to 10 centimeters from the upper ones. In principle the resection should approach the spinal column as closely as possible and it is of particular importance to pay close attention to just this point during resection as one is otherwise surprised at the length of the stumps remaining. If the stumps are too long the collapse effect is usually too small and it is sometimes necessary to reduce the length of the stumps as far as the lateral processes of the spine by means of bone forceps.

The resection of the 5 upper ribs demands individual attention (second stage). Under normal circumstances with the scapula in position these ribs are covered by the scapula. Now the successful collapse of the proximal ribs is of great importance because the upper lobe is usually most deeply affected and it is therefore very necessary that precisely these ribs be extensively resected. In order to make this possible the scapula must be retracted energetically by an assistant by means of retractors (Fig. 3) this being possible

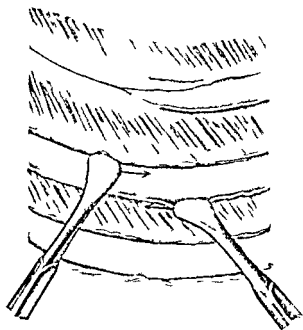


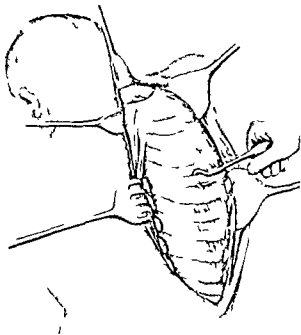
Fig. 2. The use of the rasp from the spine (right) toward the pinc on the lower edge and from the spine to the side (left) for the upper edge to free the rib of periosteum.

because of the arch incision mentioned above. In this way it is possible to resect pieces as long as 10 to 12 centimeters even in the upper ribs. The decisions as to whether larger or smaller pieces should be resected depends upon the extent and advance of the pulmonary destruction.

The most difficult part of thoracoplasty is the resection of the first rib. The resection of this rib is absolutely necessary in every case. The approach is made suitably free by firm upward retraction of the soft parts (Fig. 3). It is always necessary to take every precaution that the rib considered as the first is really the first; otherwise it is quite possible that the rib can be overlooked. This rib can be recognized by the fact that the surfaces are horizontally placed facing up and down instead of forward and backward. Since the first rib is considerably shorter than the others, it is sufficient for our purposes if we resect only 3 to 4 centimeters from it. As it is particularly difficult to resect part of this first rib special instruments are necessary, the best of these being the rasp and rib scissors recommended by Sauerbruch.

Just above the first rib the brachial plexus and the subclavian artery and vein pass by. In the event that resection is not executed with caution these structures can be damaged with the rasp as well as with the rib shears. Reports of such cases have been published. The injury to the subclavian vein may lead either to fatal hemorrhage or to air embolus and must therefore be avoided under all circumstances. But there are also secondary





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injuries to these structures such as those due to the presence of sharp edges or ends to the rib stumps. It is therefore necessary to smooth these as well as possible by means of the rib forceps.

After the operation has been completed (first and second stages) there follows exact and careful treatment of the wound. All the loose and bruised pieces of muscle which are damaged in their nutrition are excised; the large wound cavity should be douched with sterile salt solution in order that any possible bone particles may be washed away. Then the suture is carefully executed. For this purpose the shoulder is pushed backward and the edge of the wound brought closer together. The muscle suture is done carefully with the catgut button type (row in the first stage in the lower portion of the thorax and

rows in the second stage in the upper portion of the thorax). I usually put a rubber drain into the large wound cavity after the first stage or in one stage operations and leave it in for 24 hours under the musculature (Fig. 4). Following the second stage the wound cavity is usually smaller and need not therefore be drained. Finally the skin incision is sutured by means of loosely arranged silk button sutures.

As a rule patients tolerate the operation rather well. It is absolutely necessary, however, that a physician observe the pulse and the breathing during the entire course of the operation. It is also almost always necessary to administer a cardiac stimulant in the form of camphor or caffeine during the operation. I also prefer to have the patients drink some hot black coffee or some cognac during an operation which is executed under local anesthesia. Cyanosis is not infrequent during the operation for the patients lie on the healthy lung which is thus inhibited in its breathing excursions. This is of no particular importance as long as the breathing is regular, but as soon as marked dyspnea appears the operation should be immediately interrupted and improvement of the patient attempted by means of supine position, oxygen breathing, and application of stimulants. It is sometimes advisable to do the operation in 3 stages in case of very weak patients.

Sometimes a tachycardia occurs after the patient has already been placed on the operating table and this may reach 150 beats to the minute. In such cases it is best to wait until the pulse has settled or to give stimulants (cardiazol, camphor hypuratum). In the majority of cases it is possible to continue as the pulse will drop in rate and the patient become quieter. The tachycardia may be due partly to psychic excitement, but if the increased rate persists despite all measures the operation should not be carried out. In one of my patients we were able to operate successfully only after 3 attempts of this kind.

**Dressing.** I always avoid any possible compression of the wound in dressing since this annoys the patients greatly and disturbs breathing. The dressing should be very loose and I always bandage over an assistant's fist placed against the lower part of the sternum during the process. This prevents too tight a bandage. Supine position of the patient is sufficient security for the compression of the wound. This is also the reason why I avoid the non-support position of the back. The back should lie on a support and if the bandage is stuck with mastisol or the like it will not be displaced despite its looseness. I do not use the compression pillows recommended by Sauerbruch which are attached to the thorax by means of rubber bands; nor have I felt the need to use them.

#### AFTER TREATMENT

Almost upright supine position of the patient, position of the arm of the side operated upon on a pillow, all increase the comfort of the patient after operation. It is sometimes necessary to apply oxygen for breathing. It is especially

important to use plenty of morphine or pantopon during the first week following operation. The patients then cough more easily. The sputum is usually reduced during the first 2 days following operation then it becomes even more copious than before operation but is soon reduced again in quantity. The nurses should be instructed to support the movable side of the thorax every time the patient coughs and after a few days the patient can do this himself. It is important that the patients cough energetically and completely otherwise aspiration into the healthy lung is easy and this complication is always very serious. In addition to morphine and pantopon cardiac stimulants must be administered plentifully during the first few days following operation. I consider the use of antipyretics of no great necessity even if the temperature rises considerably the first few days after operation as is often the case. After a few days the temperature of itself usually drops to normal.

The interval between the first and the second stage is 2 weeks if healing and general condition are good. In the event that healing of the wound is disturbed or the general condition too weak the interval must be suitably longer. The earlier the second stage is executed the better and more complete is the collapse. After the wound of the second operation has healed completely and the patient has regained sufficient strength he must be transferred to a suitable sanatorium for a period of from 4 to 6 months.

#### COMPLICATIONS

It is possible that during the process of extracting a rib one may injure the pleura if the pleural cavity is not completely obliterated. The result is a pneumothorax which if it is accumulated is of no importance. Threatening conditions occur only if the pleura is completely free and the injury leads to mediastinal displacement due to total pneumothorax. In such cases superatmospheric breathing must be applied and the pleural wound sutured air tight immediately. If only a partial pneumothorax occurs the operation can be continued. In case of total pneumothorax due to injury of the pleura the operation is interrupted and the pneumothorax left alone. These possible accidents show how important it is to try an artificial pneumothorax before operating.

Another complication is the disturbances in wound healing which occur more frequently if the soft parts have become thickened by lymph stasis before operation. Sörgo in Vienna emphasized the dangers of this complication. In such cases the pleura also discloses a jellied appearance. Wound

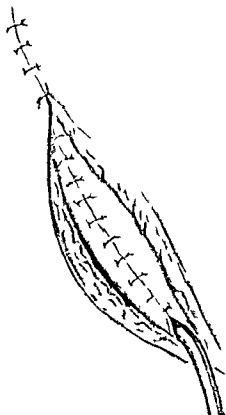


Fig. 4 Closure of wound and drainage tube in place

healing can take a disturbed course also in case of purulent pleural effusions and the protracted course can finally be provoked by infection during operation a circumstance which is not at all impossible considering the size of the wound cavity.

Complications may also arise in the heart and in the other lung during the postoperative course. The latter are especially serious. These complications are either the exacerbation of latent foci or the result of aspirations of sputum containing bacilli in the course of incomplete expectoration and coughing. The pneumonia which may occur at the end of the first or the beginning of the second week after operation is usually fatal.

#### RESULTS

The effect of thoracoplastic operations depends upon the proliferating component of the process. In the essentially proliferating (productive) types the immediate mortality after thoracoplasty was 3 to 4 per cent early and tardy fatalities together made up about 10 per cent. Permanent cure and considerable improvement with freedom from bacilli was 70 to 75 per cent. The sputum is free from bacilli a few weeks after operation in some cases. The more the exudative component present the

worse are results. In these forms the immediate mortality is 5 per cent, the early and tardy fatalities together over 50 per cent. The chances for improvement are not more than 5 to 30 per cent, and in patients over 50 years are even less.

In the event that the operative result is not satisfactory and the process is still unilateral, the effect can be improved by reoperation. This may consist in renewed resection paravertebrally of the upper ribs or anterior parasternal operation. If the cavity is near the anterior wall, the resection

of the anterior rib portions (1 to 4 or 5) lead to better results. Secondary pneumolysis and plugging with paraffin can be carried out, but these are usually difficult because of induration. Threnotomy is also possible. This operation I rarely perform before a plastic operation and then only as a test operation. Otherwise I reserve it for repeated pulmonary hemorrhages. Even in very obstinate cases I have repeatedly been able to secure cure or freedom from bacilli by means of one or more operations.

BLASTOMYCOSIS OF THE ESOPHAGUS<sup>1</sup>

## REPORT OF A CASE

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S. t. S. g. I. P. th. l. g. M. y. C. l.

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**B**LASTOMYCOSIS of the skin with generalized dissemination of the disease is no longer considered rare. Many such cases have been reported by Montgomery and Ormsby, Stober and Wade and Bel, the last observers having reviewed the postmortem data in 47 cases.

It is of interest that the esophagus was involved once only in this series of cases. The patient was observed by Shepherd and Rhea and succumbed to generalized blastomycotic infection. At the postmortem examination a fluctuating area 1 centimeter in diameter was found 7 centimeters above the cardia. Every organ of the body was involved in the process except the

brain. The patient did not have symptoms referable to the esophagus.

New reported a case of primary blastomycosis of the tongue without dissemination, and Jackson, Dennis and Downing have each observed a case of primary blastomycosis of the larynx, but we have been unable to find reference to any case in the literature in which the disease was primarily in the esophagus. We are therefore reporting a case recently observed in the Mayo Clinic.

A man aged 41 years who had resided in Chicago for a number of years was examined April 11, 1927. Twelve years previously he had had pulmonary tuberculosis and bacilli of tuberculosis were found in the sputum. After a period of 4 months in a sanatorium there followed a period of excellent health for 11 years. During this time the patient had followed a strict hygienic regimen, sleeping on a porch at night. His work as an accountant was done in comfortable surroundings. Nine months previous to examination at the Mayo Clinic he noticed obstruction in the upper portion of the esophagus to the passage of solid food. This had progressed slowly to the point where soft food were taken with little difficulty. The esophagus

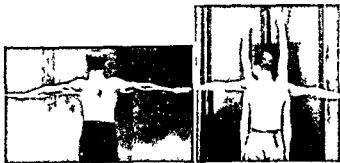


Fig. 1. Structure of the upper third of the esophagus from blastomycosis.



Fig. 2. Tissue from blastomycotic granuloma showing budding organisms.





with a specially bent elevator perforated at the end around the surgical neck of the humerus and a double knot is made on the anterior side over the joint. We therefore have four strong silk ligatures parallel to each other on the anterior surface of the joint. These are transfixed and well knotted to the coracoid process which is well exposed. The origin of the biceps muscle which is on this process prevents the slipping of the ligatures. The four threads form a strong band lying on the anterior surface of the joint. The capsule on both sides of this band is now lifted and the folds are sutured around the silk band. Therefore the sheath in which the silk band now lies is exactly similar to that of the tendon of the long head of the biceps muscle passing the shoulder joint.

We have therefore at this point which is the weakest point an artificial reinforcement of the capsule and also a shortening of the joint capsule space which we have gained by the folding over

It should be explained that the silk thread which we use has a tensile strength of 40 kilograms (86 pounds) so that with one ligature we have a resistance of 80 kilograms and with the entire band a resistance of about 160 kilograms.



First Before the operation dislocation occurred as much as 5 times a week. Since the operation (1924) dislocation has not occurred once. The pictures show the normal amount of motion after operation.

The flap is now replaced and with perosseous sutures the deltoid tendon is fastened at the place of its insertion on the humerus

After a period of rest of 4 weeks the patient begins careful exercises

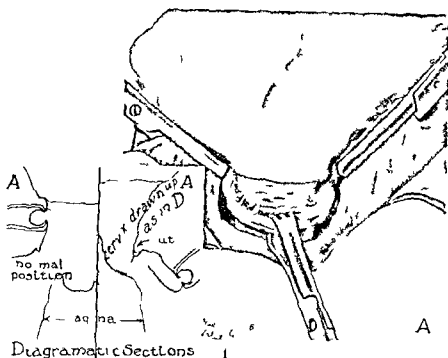
In the cases operated upon by this method the patients recovered complete working capacity and regained free motion in the joint. Dislocation which had been common at short intervals never recurred.

## A SIMPLE METHOD OF REMOVING THE CERVIX WITH THE UTERUS IN HYSTERECTOMY

By FRANK H. LAHEY, M.D., F.A.C.S., Boston

IN July 1931 we published a description of a method of excising the major portion of the cervix with all of the cervical canal in hysterectomy for benign lesions. On account of the good results following its use in several cases we recommended its employment because it had resulted in the desirable accomplishment of excising practically the entire cervix together with the uterus without added danger to the ureters.

with but slight added difficulty to the operation without shortening the vagina during the period of sexual activity and with preservation of the cervical shell into which the broad and round ligaments are inserted thus preserving a valuable structure for the support of the vagina and bladder. Further employment of this procedure in the clinic has not lessened our satisfaction with it. We have now employed this technique in 12 hysterectomies with complete satisfaction and



Diagrammatic Sections

P A The t e t h l cl mp d th l ll Th t f l m  
 m d d t l a t t t r d h a p d w th l bl hook Th t f l m  
 tr t i g m t ll th h m f h th O d th  
 l b n m d th f fl t d pth t m k th l h ll wh h  
 t m l f tl h ll ha b t j t l l n Th h f d ep t  
 the p t n f th h h t b ed th l ht e t th l ll  
 f th t l l h t l ll t l v n d O th th d f th t l th  
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again with to direct attention to its value as well as to add a few technical steps developed after further experience which make the operation easier.

Transcervical removal of the cervix should be undertaken only in those cases in which an adequate exposure of the cervix and pelvic fossa can be obtained. This will be possible in practically all cases except those in which the size of the uterine tumor together with inability to deliver it will prevent satisfactory demonstration of the complete circumference of the cervix down to its attachment to the vagina. In cases presenting difficulty in exposure a simple transverse incision of the cervix with an attempt at cervical removal will be safer and more satisfactory.

As stated in the original description of this operation bleeding and oozing during the excision of the cervix is considerably greater than during the simple supracervical hysterectomy and the greatest drawback to the operation. At no time however has bleeding been uncontrollable or excessive in our hands. It has been bothersome only

in that it lessens the neatness of the appearance of the operative field. While the neck of the uterus is being excised from its cervical shell the oozing is considerable but is immediately controlled as soon as the vaginal supports are sutured into the cervical shell. By the introduction of the corner of a folded towel into the fossa of Douglas we have succeeded in catching the small amount of blood which comes from the oozing so that after the mattress suture in the cervical shell is inserted the oozing of the cervix completed in bleeding controlled the towel with any small accumulation of blood clots on it may be lifted out of the pelvis.

The particular point which we wish to demonstrate is the application of double hooks such as we have employed in gynecologic surgery to the front and back of the thin shell of cervical tissue which is to be left behind so that with one assistant pulling up on the uterus and the other pressing the anterior and posterior double hook down on the shell of cervix which is to remain may be gradually everted as the excision of the cervix is

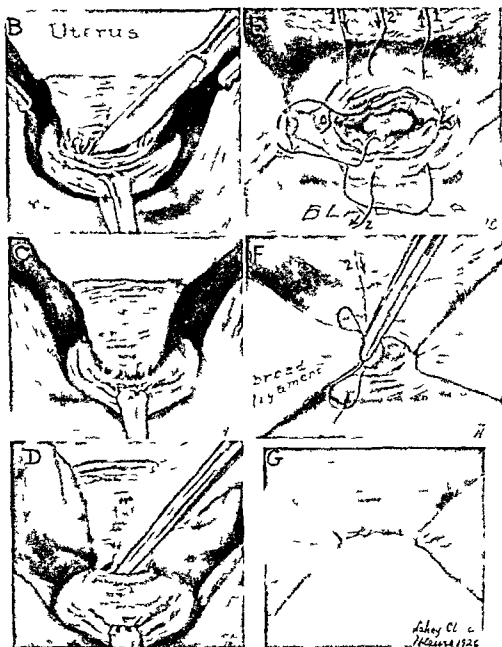


Fig. B. The antero double hook only is shown attached to the shell of cervical tissue which is being pushed downward as the uterus is pulled upward and the dissection of the cervix continued.

Fig. C. The same further advanced showing the fold which develops between the cervical shell and the cervix and in which the dissection should be carried out.

Fig. D. The cervix completely dissected the opening into the vagina made on the anterior wall and the thin strip of gauze being passed through it into the vagina. As soon as all of the gauze has been passed into the vagina so that no vaginal secretions may flow back up into the peritoneal cavity the cervix is completely detached from its vaginal attachments.

Fig. E. The cervical remnant seen from above. The everted shell has been inverted and the gauze strip in the vagina may be seen. The mattress suture *x-x* is shown grasping the entire cervical shell and introduced low down the bladder having been wiped off in front. This stitch must be accurately introduced as it is the stitch which prevents postoperative bleeding into the vagina.

Fig. F. The broad and round ligaments separately or together may be introduced and sutured deeply in the shell. The mattress suture should be tied last after introduction of the ligaments into the cervical pocket and closure of the cervix.

Fig. G. The usual peritonealization of the stump.



carried down to its vaginal attachment just as a finger is extracted from a finger cot by grasping the base of the cot and pulling the finger out of it

The technical steps of the operation may be grasped from the Figures 1 to 7 with the attached legends

The introducing into the vagina of a strip of gauze which has been unfolded and pulled out into a narrow ribbon is of advantage in keeping the secretions of the previously painted vagina out of the cervical shell and providing a small pack at the vaginal orifice of the cervical shell to control any small oozing not taken care of by the cervical sutures and mattress stitch

In describing any operative plan which differs from those commonly employed it should be the duty of the describer to set down any complications which have arisen in its use. Therefore it is only fair to say that in 6 of the first 20 cases in

which this scheme of cervical removal was employed there was so much uncontrolled oozing into the vagina from the canal of the cervical shell that re-etherization and suture of the lower end of the cervical shell through the vagina was necessary

Since the early cases however since we now wipe the bladder well off the anterior surface of the cervical shell and upper vaginal wall so that the mattress stitch for control of oozing may be placed low in the cervix close to its attachment to the vagina no further difficulty of this nature has arisen and vaginal suture of the cervix has never been necessary

From our experience with the procedure we know of no drawback to its use and recommend its employment in all patients upon whom hysterectomy is performed for a benign lesion in which adequate exposure of the cervix may be obtained

## SURGICAL PROCEDURE IN OBLITERATIVE VASCULAR DISEASE (THROMBO-ANGIITIS OBLITERANS)

### A REPORT OF FORTY FIVE CASES<sup>1</sup>

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A. D.

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**O**BLITERATIVE thromboangitis (Buerger's disease) usually affects males between the ages of 17 and 40 years. Juvenile and presenile gangrene have been used to designate the obliterative vascular lesion occurring chiefly in the extremities which is now known as thromboangitis obliterans. Buerger first described the condition as a definite pathological entity and clearly demonstrated the essential differences between this condition and arteriosclerotic disease of the extremities.

Excessive fatigue of the extremities or claudication pain brought on by exercise and relieved by rest is experienced early and is manifested by pain in the calf, hand, or single digits. Soon after or coincident with the color change there is a continuous burning or aching pain largely limited to the digits, not related to exercise and partially relieved by the dependent position and heat. With the occurrence of marked trophic changes such as non-healing incisions or gangrene

this pain becomes sharp, is unrelieved by usual measures and frequently is unbearable requiring amputation for relief.

Objectively the earliest manifestation is the bluish red discoloration of the digits increased by the dependent position and minimized by elevation (Fig. 1). The extremities are cold and there are diminished or absent pulsation of the arteries and mild trophic changes such as abnormal calluses and linear breaks in the skin. Later dry gangrene may occur spontaneously but is more often incited by trauma, infection or infection. In approximately 25 per cent of the cases the complaint is referable chiefly to the lower extremities. In 50 per cent there is some degree of arterial obliteration in the upper extremities. Symptoms are rarely referable to this region. Pathologically the process is an inflammation affecting primarily the main arteries and veins of the extremities. An obliterating thrombus occurs which successively undergoes organization and fibrosis (Fig. 2). The



Fig. 1. Foot in a case of thrombo angitis obliterans. In the dependent position there is bluish red discoloration of the toes and distal part of the foot. The fourth toe is gangrenous and there is impending gangrene of the great toe. A small area of superficial phlebitis is present above the second and third toes.

end stage is an organized thrombus in which new vascular channels occur. These are at first discrete later they are fused into larger channels. Perivascular fibrosis binds together the nerve, artery and vein.

#### CASES STUDIED

In approximately 80 per cent of the 100 cases in this series a diagnosis had not been made or it had been made incorrectly previous to the patient's admittance to the Mayo Clinic. In the stage of the disease when the toes become red and painful and with symptoms and signs indicating an insufficient blood supply incisions for deep seated infection or removal of ingrown toe nails are frequently carried out. Gangrene is initiated by this procedure in 35 per cent of the cases. This is significant since the outlook for eventual recovery is greatly lessened in the presence of gangrene or non healing incisions. Toes are amputated in cases in which there is obstruction of the proximal vessels and if the blood sup-

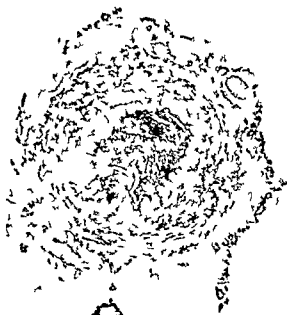


Fig. 2. An artery in a case of thrombo angitis obliterans. The lumen is occluded by an organized thrombus in which new channels have formed. There is lymphocytic infiltration of the arterial wall and surrounding tissue and many newly formed vessels in the periarterial tissue.

ply is inadequate. Nonhealing of the incision followed by gangrene is the result. Amputation is frequently performed above the knee without sufficient consideration of the necessity of a functioning knee joint. This is important in thrombo angitis obliterans which occurs usually among young persons dependent for a livelihood on the maintenance of function in the lower extremities. Amputation below the knee may be unsuccessful but usually because valuable methods which may be easily utilized and which increase the possibility of primary healing are neglected.

It is our purpose here to analyze carefully these surgical procedures. In a group of 150 cases of thrombo angitis obliterans observed in the years 1933-1936 surgical procedures were carried out in 45 cases at the Mayo Clinic or elsewhere. These 45 cases form the basis of this report. In all instances the term successful refers to healing by primary intention. Prolonged healing refers to healing prolonged for 2 months or more and unhealing refers to the condition at the time of observation or at the time of latest information.

#### SURGICAL PROCEDURES

The surgical procedures of incision or amputation in thrombo angitis obliterans can be conveniently grouped as (1) incision of toes or removal of toe nails, (2) amputation of toes, (3) amputation below the knee and (4) amputation above the knee.



Fig 3

Fig 4

F 3 I t f s l m p t a n f the  
t thr mb a t l l t n th th omb f th  
s ls f th t N t m l app f m  
t an l k f f t f h l p l a t d o mally

F 4 A t m p u t t n a f th omb a m t  
bl t a The m p t t h d b pr r  
63 a pe od du g l ch t me th p t e t n t  
d b l d

*Incision of toes or removal of toe nails* In 15 cases the incision of toes or removal of toe nails (elsewhere) was successful in only 1 case (Table I) in which higher amputation was later required for a similar condition in other toes. In 1 case of prolonged healing higher amputation was performed later. In 13 cases in which incisions did not heal higher amputation was required in 9. In the remaining 4 cases the incisions had not healed at last reports and there is a probability that higher amputation will be necessary.

*Amputation of toes* Toes were amputated in 6 cases at the Mayo Clinic (Table II). The operation was successful in 4 cases. Incisions did not heal in 2 cases in both of which higher amputation was required later. Amputation was carried out in these cases at the insistence of the patients. In 25 cases 1 or more toes were amputated elsewhere. In 5 of these healing was prompt but in 1 amputation at a higher level was later required. In 10 cases healing was prolonged in 3 of which amputation at a higher level was necessary. In 9 of the cases in which amputation was done elsewhere the incision failed to heal and higher

amputation was later necessary in 7. The probability of higher amputation at a later date in the cases in which healing was designated as prolonged or absent must be considered. Of the 31 cases in which amputation was performed at the Mayo Clinic and elsewhere healing by primary intention occurred in 9. In 1 of these in which amputation was done elsewhere the available data are not sufficient for consideration. In 3 of the 6 remaining cases sudden thrombosis occurred in 1 or 2 toes and in 1 of these the vessels of the feet pulsed normally. In the 3 other cases pulsations were normal in either the dorsalis pedis or posterior tibial vessels. In the successful cases the average pulsation in the dorsalis pedis vessel was 1 and in the posterior tibial 1 to 2 (on a scale of 0 to 4). In the unsuccessful cases the average

TABLE I—RESULTS OF INCISION OF TOES OR REMOVAL OF TOE NAILS IN FIFTEEN CASES (OPERATION ELSEWHERE)

Case	Successful	Healed	Amputated	Not healed
Successful	1	1	1	1
Healed	1	1	1	1
Amputated	1	1	1	1
Not healed	1	1	1	1

TABLE II—RESULTS OF AMPUTATION OF TOES IN THIRTY ONE CASES (SIX OPERATIONS IN MAYO CLINIC AND TWENTY FIVE ELSEWHERE)

Case	Successful	Healed	Amputated	Not healed
Successful	4	4	4	4
Healed	4	4	4	4
Amputated	4	4	4	4
Not healed	4	4	4	4

TABLE III —RESULTS OF AMPUTATION BELOW THE KNEE IN TWENTY ONE CASES (TWELVE OPERATIONS IN MAYO CLINIC AND NINE ELSEWHERE)

	Mayo Clinic	Elsewhere
Successful not requiring higher amputation	9	1
Prolonged not requiring higher amputation	1	1
Unhealed requiring higher amputation	2	2
Elsewhere		
Successful not requiring higher amputation	6	1
Prolonged not requiring higher amputation	1	1
Unhealed requiring higher amputation	1	1
Unhealed not requiring higher amputation	1	1

pulsation in the dorsalis pedis vessels was 0 to 1 and in the posterior tibial 0

*Amputation below the knee* Amputation was performed below the knee in 12 cases at the Mayo Clinic (Table III) Healing occurred by primary intention in 9 cases it was prolonged in 1 and absent in 1 Accessory measures to stimulate healing were not carried out in either of these 2 cases both of which required higher amputation later In 9 cases amputation below the knee was performed elsewhere in 6 healing was prompt in 1 it was prolonged and in 1 it was absent In 1 of the latter amputation at a higher level was necessary later In the total of 1 cases healing by primary intention occurred in 15 cases (71 per cent) and was delayed in 10 per cent In only 4 cases (19 per cent) was there failure to heal A comparison of the successful and unsuccessful cases shows only insignificant variations in average age average amount of rubor with the foot dependent average amount of pallor with the foot elevated and in the average severity of the rest pain In the unsuccessful cases the average duration of symptoms was 6 years twice that in the successful cases Pulsation in the popliteal dorsalis pedis and posterior tibial vessels was always absent in the unsuccessful cases but sometimes present in the successful cases Pulsation however was absent in the popliteal artery in some cases in which amputation below the knee was successful

*Amputation above the knee* This operation was performed at the Mayo Clinic in 7 cases (Table IV) In 6 of these healing was prompt and in 1 it was prolonged In 1 case high amputation was performed because of extensive gangrene of the foot and deep gangrenous ulcers over the tibia and knee in 1 it was performed because of previous unsuccessful amputation below the knee in 1 because of previous unsuccessful amputation of the toes and in 1 because the patient was admitted with extensive gangrene of the foot and was extremely toxic because of absorption from the

TABLE IV —RESULTS OF AMPUTATION ABOVE THE KNEE IN SIXTEEN CASES (SEVEN OPERATIONS IN MAYO CLINIC AND NINE ELSEWHERE)

	Mayo Clinic	Elsewhere
Healed not requiring higher amputation	6	1
Prolonged not requiring higher amputation	1	1
Elsewhere		
Healed not requiring higher amputation	8	1
Unhealed not requiring higher amputation	1	1

gangrenous ulcer In the 3 remaining cases amputation was performed above the knee at a time when high amputations were thought necessary Amputation above the knee was performed elsewhere in 9 cases in 8 of which healing was prompt it was prolonged in 1 case

# DISCUSSION

The indications for amputation are not clearly defined in cases of thrombo angitis obliterans Careful observation of such cases has shown that function in the diseased extremity is re established in many cases by medical treatment This is true in cases of gangrenous ulcer which heals spontaneously or in cases of gangrene in which auto amputation occurs Mills states that auto amputation of the toes frequently occurs in the stoic Chinaman and function in the foot remains Several cases of this type have been observed at the Mayo Clinic (Fig 3)

The economic factor in cases of thrombo angitis obliterans cannot be overlooked The disease usually occurs in patients with limited finances Whether it is better to treat a patient medically over a period of months or years with almost complete disability during this time and with uncertain results or to proceed with more radical treatment with the hope of a shorter period of economic loss is a question There is no general solution of this problem Each case requires individual consideration Either intractable pain or gangrene extending above the toes is always a clear cut indication for operation Pain may frequently be relieved by the repeated use of vaccines (3) by radium chloride (1) and in selected cases by lumbar ganglionectomy (3) In our experience gangrene of such severity has not healed spontaneously Cases of gangrene affecting only the toes in whole or in part should be treated medically provided pain can be relieved and economic conditions permit it

Cases treated surgically should also be treated medically to increase the blood supply postoperatively especially if the success of the operation is doubtful The application of radiant heat by

means of the carbon filament electric bulb arranged in an arch over the bed is helpful and should be given for from 2 to 4 hours twice daily. Care must be used to avoid burning. Triple typhoid vaccine is of value if given intravenously in amounts sufficient to produce a mild chill and a systemic fever of or 3 degrees Fahrenheit. The usual amount is from 10 000 000 to 50 000 000 killed organisms. This treatment can be begun on the third day after operation and given daily or on alternate days. Postoperative complications such as pneumonia or shock are contra indications. Brown has shown that this method of treatment increases the temperature of the skin and the rate of heat elimination from the extremities. With increased blood supply to the extremities healing is facilitated.

The level for amputation needs careful consideration. There are no indications for the incision of toes or the removal of the nails. The frequency with which these procedures are carried out in clinics is a definite lack of knowledge regarding the nature of the disease process. The two misleading symptoms are pain and redness of the toes. The obvious inference is that a deep seated infection exists. This in a measure is true but the absence of heat in the digit, the presence of similar rubor of lesser degree in other toes, the absence or diminution of pulsation in the main arteries of the feet, the history of or presence of superficial phlebitis or the presence of symptoms indicating a vascular occlusion (excessive fatigue or pain of the calf arch or ankle) give ample evidence of an underlying obliterative vascular disorder. Non-surgical methods for relief of the pain, consisting of the intravenous injection of foreign protein (1) or radium chloride (2), protection of the extremities from trauma and medical and physical measures to increase the blood supply (3) are indicated in these cases. If pain can be relieved and trophic changes avoided, sufficient circulation may be eventually established.

The amputation of toes may be successful in types of cases those in which there is sudden thrombosis of the vessels of the toes and those in which either or both of the main pedal vessel pulsate normally indicating that the vascular occlusion is distal to the arteries (Fig 4). Thrombosis of the toe is manifested by sudden bluish black discoloration usually of 1 or more toes with failure of return to normal color within 3 or 4 days. In our experience this occurred in case in the early or milder stage of the disease with but little other evidence of obliterative vascular disease. It constituted an early sign of or true obliterative lesion of the arteries. Amputation in case

of thrombosis of the toes is only justified if there are open vessel and the skin appear normal proximally.

Amputation of the distal half of the foot or above the ankle has not been attempted. Healing would not be expected to occur at those level and even in successful case the function would not be better than in cases successfully amputated below the knee.

Amputation in the region of the knee is necessary in case of intractable pain or of gangrene of the toes or feet unless it is possible to amputate the toes successfully. Amputation below the knee is not commonly acknowledged to be successful. Buerger reported 63 cases in which he performed the Gritti Stokes amputation above the knee and believed this to be the most satisfactory operation. Telford and Stopford were of the same opinion. Jablonski believed that 50 per cent of his cases were suitable for amputation below the knee.

In our series of 21 cases in which amputation was performed below the knee there was healing by first intention in 15 cases (70 per cent). In 2 other cases healing was prolonged. The importance of a functioning knee joint obtained by amputation below the knee cannot be too strongly stressed.

Criteria for selection of the level with the knee are not definite. Buerger believed that method or tests for stimulating the point at which operation should be done are all unreliable. Meloney and Miller amputated below the knee in all cases if there was pulsation in the popliteal artery and above the knee in all cases in which the popliteal artery was occluded. The results were not encouraging. Bean advised amputation above the site of closure of the main arteries. In many of our cases of successful amputation below the knee the popliteal artery was completely occluded. In cases of edema of the leg of extension gangrene of the foot and leg, if gangrenous ulcers over the tibia or knee or of extensive cellulitis and lymphangitis the chance for successful amputation below the knee are less. In all other cases there is roughly an 80 per cent possibility of primary healing. It is a well established postoperative method for increasing the blood supply to the stump are utilized. Attempts should be made to remove the edema by means of elevation and diuretics such as ammonium chloride and merbaphen. The patient usually willing to take the 80 per cent chance for successful amputation below the knee in order to have a functioning knee joint. This explains the high left of opinion with the patient. Later amputation at a higher level in unsuccessful cases is not attended by an increased risk except in patients of

more advanced age whose gangrene is arteriosclerotic in origin. Amputation above the knee should be reserved for cases in which previous amputation below the knee was unsuccessful for cases in which infection or trophic changes are extraordinarily extensive and for patients unwilling to take the 50 per cent chance of failure of amputation at a lower level.

## SUMMARY

Incision of toes or removal of toe nails should not be performed in cases of thrombo-angitis obliterans. Amputation of toes can be successfully accomplished in selected cases. In approximately 80 per cent of all cases (excluding those complicated by edema, cellulitis or extensive gangrenous changes) amputation below the knee can be successfully carried out provided post-operative medical measures to increase the blood supply to the stump are instituted. The results demonstrate the value of close co-operation between the clinician and the surgeon. Such results

cannot be obtained in older patients whose gangrene is arteriosclerotic in origin.

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## THE DELIVERY OF THE ADHERENT PLACENTA

REPORT OF THREE CASES IN WHICH THE MOJON GABASTON METHOD WAS EMPLOYED<sup>1</sup>

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**M**ANUAL removal of the adherent placenta is one of the most dangerous procedures in obstetric practice. According to Bumm (5) there is a 10 per cent mortality following this operation and the morbidity from uterine infection has been variously estimated in the neighborhood of 5 per cent. Infection from implantation of the micro-organisms at the placental site, hemorrhage during and after the operation, shock due to the extraction and occasionally rupture of the uterus are the hazards of manual removal.

In the Mojon Gabaston method we have a means of effecting the delivery of the adherent placenta without intrauterine exploration. Briefly, this method consists in the injection of warm sterile saline solution into the placenta by way of the umbilical cord vein so as to distend and rupture the placental vessels and form a retroplacental hydroma; then separation of the placenta takes place in response to the mechanical action of this hydroma.

The value of so simple a method of delivering the adherent placenta is apparent. Even in a well-equipped hospital it has obvious advantages over manual extraction when it proves effective. And to the physician who must work in small communities and conduct his operations under conditions in which a sepsis is imperfect it offers a special appeal. To the practitioner who finds himself confronted with the problem of an adherent placenta while delivering his patient in a country home where trained assistants cannot be had, an alternative to manual extraction is certainly of advantage. Furthermore, in cases of precipitate labor when there is no time to shave and prepare the external genital properly, the danger of intrauterine interference is considerably increased when the Mojon Gabaston method offers greater safety.

It is for these reasons that I am reporting three cases in which the use of the Mojon Gabaston method brought about prompt delivery of the adherent placenta with an uneventful recovery.

## MANUAL EXTRACTION DANGEROUS

It is usually assumed that the placenta is abnormally adherent when it is not delivered within hours after childbirth. In my experience however what is termed an adherent placenta often proves to be only retention brought about by partial closure of the retraction ring. This view is supported by the opinions of other workers. Williams (20) states: "In the vast majority the term *adherent* placenta is a misnomer since the interference with its expulsion is usually due to abnormalities in the uterine contractions rather than to abnormal adhesions between it and the uterine wall. According to Edgar (11) adhesions between the placenta and the uterine wall are of rare occurrence for the majority of cases thus characterized are only instances of simple retention."

Practically all authorities emphasize the dangers of manual extraction. Williams (30) advises waiting for at least hours during which time repeated attempts are to be made to effect expulsion of the placenta by the Crede method. Of course if the condition of the patient is serious or there is free bleeding manual extraction must be instituted earlier. Williams holds that manual removal of the placenta must never be undertaken unless this course seems absolutely necessary as it is a more serious procedure than most of stetric operations. He points out that in the performance of a manual removal the hand is introduced between the placenta and the uterine wall and therefore comes in direct contact with the richly thrombosed vessels of the placental site which afford an excellent culture medium for the bacteria thus implanted. In other obstetric operations on the contrary the hand or instrument touches the amniotic surface of the placenta consequently if any infection is introduced it is expelled with the placenta.

Levy (17) holds that manual detachment of the placenta should be undertaken only when other measures fail not omitting their trial under narcosis. According to Sachrow (23) the manual removal of the placenta is always a serious procedure which should be performed only after the Crede method has been tried and injection of the placenta has failed. One must bear in mind that the fundus of the uterus is thinned out during pregnancy. Consequently if the placenta is either not at the site of the attachment or the uterus may be ruptured during attempts at manual removal or even by the forcible Crede expression. Such cases have been reported. In some instances an attempt at manual extraction has resulted in boring a hole

through the fundus and bringing down a loop of intestine through the rent.

The mortality and morbidity statistics following manual extraction of the placenta confirm the general opinion as to the serious nature of this operation. As has been stated before Bumm (5) attributes a 10 per cent mortality to this operation. This estimate corresponds closely to an average of all the available statistics on the subject. With regard to morbidity statistics Bourne (4) reported 54 cases of uterine sepsis 35 per cent in a series of 154 manual extractions. Coethals (14) collected a series of 156 cases with uterine infection in 39.25 per cent.

It is apparent that manual removal of the placenta is a hazardous procedure even under the best of conditions. When the operation must be undertaken in a private home without trained assistants the dangers are greatly multiplied. Therefore an alternative procedure of removing the adherent placenta without the necessity of introducing the hand into the uterus should prove of great value. And there is reason to believe that the Mojon Gabaston method does indeed fill this field of usefulness.

## DEVELOPMENT OF MOJON GABASTON METHOD

In 1914 Gabaston (13) of Buenos Aires reported an improved and satisfactory technique for the hydraulic removal of the adherent placenta a method first described by Mojon (6) of Genoa in 1886. It will be of interest to review briefly some of the outstanding reports concerning this procedure.

Mojon in 1886 described his method as follows: Water slightly acidulated with vinegar is injected with some force through the vein of the umbilical cord into the placenta after allowing the flow and expressing of as much blood as possible from this vein by way of precaution. Whether because of the sudden pressure which the injected water exerts in the fetal placental tissue or the cold which is immediately transmitted from the placenta it elf to the placental site of the uterus in any event the desired separation takes place without the necessity of introducing the hand into the uterus. In case the first injection does not prove effective a second one may be attempted after the liquid previously injected has been evacuated.

Asdrubali (1) of Rome in 1886 claimed priority for the method stating that he had lectured to his students since the year 1874 that if spirit of wine is injected into the vein of the umbilical cord it penetrates the entire mass of the placenta and diffuses evenly into the finest

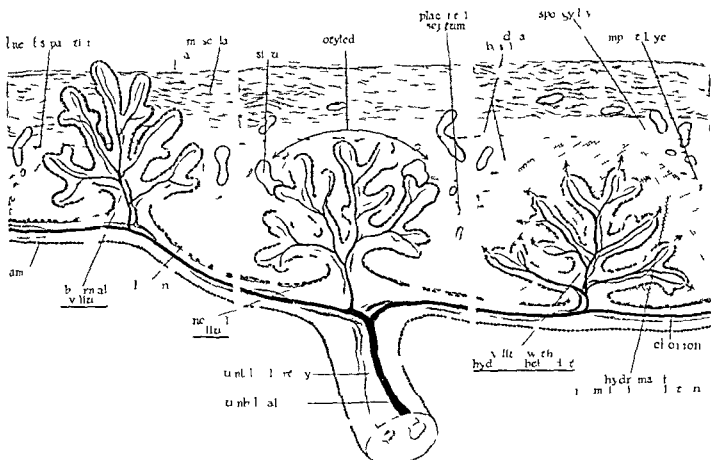


Fig. 1. Semidiagrammatic representation of the placenta and its attachment to the uterine wall to illustrate the mechanism of the Mojon-Gabaston method. Three separate placental cotyledons are shown as follows. At center normal cotyledon reaching to, but not beyond the spongy layer of the decidua basalis. The section shows two branches of the villi entering uterine sinuses. At right shows how the injection of the fluid distends and finally ruptures the finger-like projections of the villi. The cross-hatching represents the retroplacental hydrops which completely separates the cotyledon from the

maternal surface and also acts as a foreign body so as to favor expulsion. At left a cotyledon in placenta accreta. The finger-like projections are penetrating the spongy layer of the decidua basalis and the uterine muscularis. One of them has even passed through the serosa. As placenta accreta is usually a matter of degree, some of the cotyledons remaining normally attached, the Mojon-Gabaston method may be partially effective in this condition at least; it facilitates subsequent Crève expulsion or manual extraction. The horizontal dotted line in all three sections represents the line of separation.

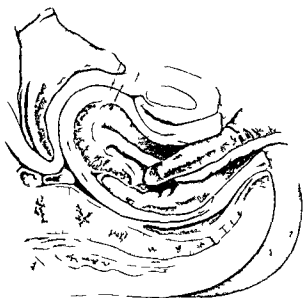
ramifications and that from that time he had conceived the idea of injecting a styptic liquid into the umbilical cord vein.

Legros (18) in 1828 found the Mojon method particularly effective in atonic bleedings. Liegard (19) in 1831 reported success with this procedure in cases in which ergot proved ineffective. Basedow (2) in 1829 tried the method several times but considered it entirely useless. Most (1) in 1834 reported that in a case of twins in which the injection was made through both umbilical cord veins, the cold developed (he employed cold water mixed with one sixth part of vinegar) caused instantaneous cessation of the bleeding and the uterus contracted and expelled the large placenta together with the fluid injected. Schwarz (24) in 1835 reported good results not only in retention but also in uterine

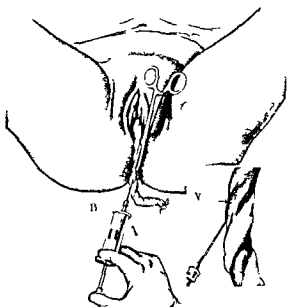
hemorrhage following partial separation of the placenta. Busch (6) in 1836 recommended the injection into the umbilical cord vein of cold water mixed with vinegar for the control of hemorrhages. D'Outrepoint (10) greatly discouraged the cold injections through the umbilical vein, stating that they give rise to sudden atony, inflammations of the uterus and eventually degeneration.

While there are many more references in the literature, nothing of real importance was contributed to the subject of Mojon's method until Gabaston in 1914 described a modern application of it. It is easy to understand why the method of Mojon, while correct in mechanical principles, should have fallen into disuse because of its crudeness and the total disregard for asepsis. The injection of an unsterile mixture of water





I S m d amm t p t t n f ma l  
t ct f th pl t l h th t ut  
h d m l t t t th f ll th ml d  
pl t l u I th b t t p t th h d  
t l th u f f th n t th l t ru  
l h t h v t d f f t f mm u l t t  
f th pl nta j l l g t



F 3 Th pr f m n e f tl M j G ba t m th  
d i Ti j t f arm t r l m l l sol  
t t th umb l l d Tt dl l h ld  
pl by th t v l mp B Th p t n f th y  
d dl h c d j ct m d In t h  
h th dl t od d t th mb l cal d  
p ll l tl t u Ti l t tly tl d

and vinegar into the retained placenta is of course a procedure that would never have been attempted were it not for the fact that there was no knowledge of bacteria at the time when this procedure was first employed.

The older literature shows that the Mojon method was employed by many obstetricians with a certain amount of success but with occasional mishaps due to the crudities of the procedure and the lack of asepsis. As much of this work was performed before the era of bacteriology the unfavorable results due to infection cannot greatly influence our appraisal of the Mojon-Gabaston method as now employed. However the reader who wishes to obtain more detail on this subject will find a complete survey of the literature in the article by Koerting (16) published in both German and Spanish.

#### RECENT REPORTS ON GABASTON'S TECHNIQUE

Gabaston's favorable report has been confirmed by a considerable number of other workers but very few of the papers have appeared in English. Triugott (1) in 1917 reported five cases in which placenta retained from 10 minutes to 15 hours were easily removed by this method. In the Frankfurt Clinic the results were reported

in 158 cases of placental injection and the ratio in which manual extraction was required was reduced from 4 cases per thousand in 1911 to 1 in 1916. Schwarz (24) in 1920 employed the method successfully in 11 of 16 cases, 2 of the 5 unsuccessful cases proving to be placenta accreta. Wagner (8) of the German University in Prague favors the Mojon-Gabaston method and maintains that the incidence of manual removal of the placenta has thereby been reduced exactly one half. He is of the opinion that the Mojon-Gabaston method is destined to replace not only manual removal of the placenta but also the Crede method of expulsion. In this view he may be a little overenthusiastic. Chatillon (8) also effected a 50 per cent reduction in the number of cases requiring manual extraction by means of the hydraulic method.

Hammerschlag (15) in his *Lehrbuch der operativen Geburtshilfe* comments favorably on the Mojon-Gabaston method and cites a case in which it was used successfully. Döderlein (9) too in his *Handbuch der Geburtshilfe Operationstechnik* makes mention of this method.

Cathala and Biancamani (7) recommend hydraulic expulsion of the placenta after a difficult delivery of the child when the mother is still under the

anæsthetic as it avoids the necessity of prolonging anæsthesia. They believe that the method is contra-indicated in uterine inertia as it does not stimulate uterine contractions.

Ramos and Perez (22) in 1921 employed the Mojon Gabaston method in 28 cases of adherent placenta and were able to confirm the general impression as to its harmlessness and efficacy. In one case of twins with two placentas the hydraulic method proved exceptionally useful. In three cases of placenta previa the injection was made immediately after the birth of the child and the result was favorable in each case.

According to Koerting (16) distention of the placenta following injection of fluid through the umbilical cord vein often makes Crede expression and manual extraction of the placenta unnecessary. He is of the opinion that in order to obtain the full effect of the injection the physician should not employ expression previously. If the Crede manipulation becomes necessary the hydraulic distention of the placenta renders it more effective. Koerting believes that when there is profuse hæmorrhage or the amount of blood lost is unknown the Mojon Gabaston method is contra-indicated.

Goethals (14) of Boston believes that the Mojon Gabaston method is the procedure of choice in cases of retained unseparated placenta without hæmorrhage and that it also deserves trial when there is slight hæmorrhage with partial separation; however he does not believe that it can replace manual extraction when there is brisk hæmorrhage or prompt action is required.

It is not advisable to employ the Mojon Gabaston method as a routine procedure in all deliveries. Wuhrmann's (31) statistics covering five hundred cases in which it was used as a routine show that it has many disadvantages over expectant treatment. The duration of the third stage of labor and the amount of hæmorrhage were increased. However Wuhrmann holds that retention of the placenta constitutes an indication for the Mojon Gabaston procedure as a routine measure when there is a history of abnormal expulsion of the placenta in previous labors.

Forget (12) in 1924 reported a case in which the use of the Mojon Gabaston method gave an unfavorable reaction. Because the placenta was not expelled in half an hour water was injected into the umbilical cord vein. Gentle traction was then made on the cord and the placenta was delivered without difficulty. Half an hour later however the patient had a severe chill lasting several minutes. The author attributed this

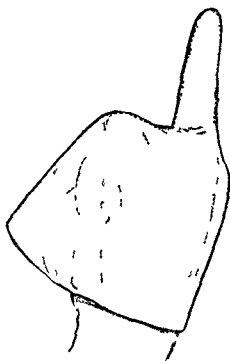


Fig. 4. Hand prepared for rectal examination. The position of the finger within the gluteal is indicated by the dotted line.

unfavorable result to the entrance of the water into some of the uterine veins and advises caution in the use of this method of delivering the placenta. It does not appear however that when warm sterile saline solution is used this reaction is likely to occur.

Some observers including W. Stoeckel (6) advise earlier and more frequent manual removal of the placenta. If the placenta is not expelled soon after the injection of the saline the patient is anæsthetized and expression by Crede's method attempted. If there is no success manual extraction is employed. One must not forget to catheterize the bladder before attempting artificial delivery of the placenta. In H. Bergmann's hospital (3) drugs are injected into the uterus through the abdominal wall and this procedure is also used before expulsion of the placenta. Although permissible in cases of great uterine atony following expulsion of the placenta injection of drugs into the uterus through the abdominal wall is not generally recommended.

#### TECHNIQUE OF PROCEDURE

The method of performing the Mojon Gabaston method is quite simple. Saline tablets for the purpose of making the physiological salt solution may be obtained at any drug store. According

to the strength of the tablet used from one to three are added to the required amount of water and this salt solution is sterilized by boiling. The average tablet is sufficient to make a normal saline solution from 4 ounces of water in any event the strength of the tablet is stated on the package.

When used the saline solution should be warm. As a general rule from 200 to 300 cubic centimeters of fluid are required more if a second injection is given. The injection is made by means of a sterile Record or Luer syringe of from 20 to 100 cubic centimeters capacity. Sometimes the introduction of 100 cubic centimeters is sufficient.

It is best to insert the needle into the cord close to the pudendum as this portion is less likely to be soiled by feces than the distal end. Another reason for selecting the cord close to the external genitals is the fact that the blood here is not so likely to be clotted. However the injection should not be made too close to the pudendum as it may be necessary to repeat it or the cord may be punctured accidentally by the point of the needle above the place of its introduction. In case the pudendum has not been prepared for labor as in a precipitate delivery the cord may be painted with tincture of iodine or mercuriochrome at the site of the injection.

The umbilical cord vein which gives rise to prominent convolutions on the surface of the cord is easily located (Fig 3 a). The needle attached to the syringe is inserted in a proximal direction into the vein parallel with its course. It is held in place by an artery clamp (Fig 3). If a second puncture should be necessary but usually it is not the first needle is withdrawn and the clamp holding it in position is tightened to prevent the return flow of saline through the puncture opening then the second puncture is made closer to the pudendal orifice (B Fig 3).

After the needle is in its proper position from 200 to 300 cubic centimeters of warm sterile physiological saline solution is injected slowly into the placenta through the vein. Then the physician waits for uterine contractions and the delivery of the placenta. Sometimes amounts of saline considerably less than 200 cubic centimeters are effective. In the first case I am reporting the placenta was expelled 10 minutes after the introduction of 200 cubic centimeters.

To determine whether the placenta has been detached from the uterus but is remaining in the cervix and vagina one should resort to rectal examination. In that event a mild cord expression will usually force the placenta out.

At this point it may not be amiss to state that the more general use of rectal examination in obstetric practice should be encouraged especially for physicians doing general work. Many authorities hold that the patient is often potentially infected before labor because she is then examined before her genitals are shaved and cleansed and the physician does not prepare his hands sufficiently for a vaginal examination at that time. During delivery most practitioners are sufficiently careful with their asepsis but many are not equally cautious before the onset of labor.

Once one has become accustomed to the practice the rectal examination is easily performed. For this purpose the physician should carry with him a one finger glove which is inexpensive and requires only boiling, powdering and preservation in a clean dry towel. Such a glove may be used for months without tearing. Figure 4 shows how the glove is slipped over the index finger and outlines the position of the remainder of the hand. By means of the rectal examination one can without loss of much time determine whether the patient is in labor and whether she should be prepared for delivery or allowed to wait for a time.

The physician with a surgical conscience who is strict in his asepsis and unwilling to jeopardize his patient's life for the sake of his own convenience but who is nevertheless pressed for time frequently finds himself in a dilemma. He cannot spare the time necessary for proper preparation for vaginal examination on the other hand if he omits the examination the patient may undergo precipitate labor during his absence in attendance on another patient.

The rectal examination offers the ideal alternative. It is both safe and rapid and also gives the examiner all the necessary information concerning the progress of the labor. It is for this reason that I have taken the space to urge a more general use of rectal examinations in obstetric practice.

#### REPORT OF CASES

Three cases of adherent placenta in which this organ was expelled in from 10 to 40 minutes after the employment of the Mojon Gabaston method are here reported. In each case the puerperium was uneventful.

CASE 1. P. S. A. D. 6. P. R. A. I. M. T. D. T. E. B. H. D. D. H. P. T. I. J. A. S. I. O. 4. T. H. M. M. I. R. A. S. H. I. R. U. P. T. D. I. N. T. A. W. I. L. Y. B. A. F. I. M. R. T. I. C. A. M. U. H. I. T. H. R. T. B. I. I. D. T. T. A. T. I. T. F. G. R. T. H. T. T. R. U. L. I. R. A. T. I. O. N. A. L. I. H. A. D. T. B. T. R. A. D. I. M. A. C. T. H. I. N. G. R. S. I. N. T. I. E. A. N. A. S. H. H. D. T. I. N. D. T. H. E. T. I. M. P. E. T. O. R. 4.

degrees F. No fetal heart sound were elicited. When the cervix was sufficiently dilated and the presenting part was in the mid pelvis, medium high forceps were applied and a stillborn child delivered thirty minutes later the patient began to bleed but not alarmingly. Then an attempt was made to expel the placenta by Credé expression but it was unsuccessful.

After a wait of 1 hour and 30 minutes it was decided that further means would have to be taken to effect the delivery of the placenta. Since the patient had had her fingers in the vagina on several occasions during labor and consequently the possibilities for infection were very great, I was reluctant to resort to manual extraction and decided to employ the Mojon Gabaston method.

One hundred cubic centimeters of warm sterile normal saline solution were injected into the umbilical cord vein by means of a 30 cubic centimeter Record syringe. Within 30 minutes the patient had a strong pain and expelled the placenta.

Four hours later the temperature dropped to 100 degrees F. The patient ran a fairly normal postpartum course except that the temperature rose to 101 degrees F on the third day when the breasts were distended. She was discharged on the tenth day in good condition.

CASE 2. B. S. aged 32 in para 1 was admitted to the Beth David Hospital January 15, 1924. There was a normal birth at term. The duration of labor from the first pain to the birth of the child was 5 hours and 35 minutes.

One hour after delivery mild Credé expression was performed but the placenta was not expelled. As there was no bleeding I waited 4 hours before invading the uterus then I explored the uterine cavity and found the placenta firmly adherent.

Rather than attempt manual separation I resorted to the Mojon Gabaston method. Two hundred and fifty cubic centimeters of warm sterile normal saline solution were injected into the umbilical cord vein after which I waited for another 40 minutes. Then the uterine cavity was explored again but the placenta came out with the mere introduction of the gloved hand. The solution had evidently effected mechanical separation of the placenta so that only the stimulation of the hand was necessary to cause its expulsion.

The patient was discharged well on the tenth day. During her entire stay in the hospital her temperature never rose above 99.5 degrees F.

CASE 3. M. W. aged 22 gravida I married 2 years was admitted to Sydenham Hospital April 8, 1927. The membranes had ruptured an hour and a half previously. The patient had a long difficult first stage of labor but was delivered of a girl weighing 7 pounds 12 ounces 4 hours after admission. The mother was very obese and heavy and distinctly of the hypothyroid type. She weighed 244 pounds and was 5 feet 4 inches tall.

One hour and a half after the delivery of the child the placenta had not yet been expelled. In a patient so extremely obese manual extraction would have been very difficult since there was very little room in which to work no matter how widely the thighs were separated. The Mojon Gabaston method was employed.

Eighty cubic centimeters of warm sterile normal saline solution were injected into the umbilical cord vein. Five minutes later the patient had a pain but the placenta was not ejected. Then 60 cubic centimeters more of the solution were injected and within 10 minutes the patient had 10 pains and expelled the placenta.

The puerperal course was uneventful and the temperature remained normal throughout the period. The patient was discharged well on the tenth day.

## SUMMARY

Various statistics demonstrate that manual removal of the adherent placenta is a dangerous procedure. It has been variously estimated that the mortality is 10 per cent and the morbidity from infection of the uterus 25 per cent following this operation.

The Mojon Gabaston method offers a useful alternative especially in outlying homes where skilled assistants cannot be obtained and sepsis is necessarily imperfect. Essentially this method consists in the injection of 200 to 300 cubic centimeters of warm sterile normal saline solution into the placenta through the umbilical cord vein. This solution distends the placenta and ruptures the small vessels connecting it with the placental site of the uterus thus forming a retroplacental hydroma, the mechanical action of which produces separation and expulsion of the placenta.

The great majority of workers who have used the Mojon Gabaston method report results superior to those following manual extraction. In the three cases reported by me the placenta was delivered in from 10 to 40 minutes and the course of the puerperium was uneventful.

The following points with regard to the application of the Mojon Gabaston method deserve special mention:

- 1 The procedure is simple requiring only a few saline tablets for the solution and a Record or Luer syringe.

- 2 No anesthetist is required as for manual extraction.

- 3 It is not necessary to rescrub or change gloves.

- 4 Since the injection is made into the unsoiled portion of the protruding umbilical cord there is no danger of carrying infection.

- 5 In placenta accreta there is a possible chance of securing separation by the Mojon Gabaston method or by this procedure in conjunction with Credé expression. Furthermore even if the injection of the saline does not prove effective it facilitates the subsequent manual removal of the placenta.

- 6 In precipitate labor when there has been no time to prepare the external genitalia properly manual extraction is hazardous because of the great likelihood of subsequent infection. In such cases the Mojon Gabaston procedure is much to be preferred.

- 7 The site of the injection may be touched with tincture of iodine or mercurochrome. The bladder should always be emptied before the injection.



THE ESTIMATION OF PERMANENT FUNCTIONAL DISABILITY  
FOLLOWING FRACTURES

BY RUTH M. CHITT AB MD FACS (FRC) BAY WISCONSIN

At the present time every physician in active practice is called upon frequently almost daily to examine and treat patients who have been injured in industrial occupations the majority of injuries occurring under such circumstances comes directly within the scope of workmen's compensation legislation. Among such injuries fractures of bone assume a position of great importance because some degree of permanent disability is a very frequent sequel. To call attention to the principal factors which may aid in forming an opinion as to the degree of this disability is the object of this paper.

Many injuries while ever cause only temporary disability. That is to say when healing has taken place the cure is complete and the workman so far as he or anyone else is able to discover and so far as his working capacity goes is as good as he was previous to his injury. The time required to effect the cure may vary from a few days to several months or even longer the disability may be very slight or only partial or it may be complete while it lasts regardless of all this the essential feature of such disability is that it is *temporary*. In all such cases after the treatment has been successful the only question remaining for the surgeon to decide is as to the length of the period of disability in other words upon what date did the healing period end and when was full functional capacity re-established? This period of time determines the amount of compensation which in these cases indemnifies only for the time lost from work. As a rule the answer to the above question is fairly easily given.

When however as is unfortunately often the case the injury owing to its nature determines a *permanent disability* or reduction in functional capacity the problem confronting the surgeon is not so simple. This disability may be complete or partial in the latter case it becomes the duty of the surgeon to estimate the degree. While it is true that most of the various state compensation acts contain specific schedules of indemnities for certain definite injuries such as amputation etc. it is obviously impossible that these could cover the whole field. It is also true that frequently these specific schedule represent mere arbitrary values which have been assigned to certain specified disabilities such values may or may not

express a true estimate. Be that as it may we are not here concerned with definite specific disabilities or mutilations for which definite indemnities are provided by law. But it is apparent that the range of possible disabilities is entirely too great too many unknown factors enter into the healing of wounds each patient is too individual in his reaction to injury for any law to be framed which could assign a specific indemnity to every injury. Hence every case not covered by a specific indemnity in a law must be examined carefully and an evaluation of the existing permanent disability made as a result of such examination.

Disability or loss of function may be viewed under several different aspects. In the first place we may have an *anatomical* disability. In these cases there is an actual loss of some portion of the organism as in an amputation of a leg. The disability may be *functional* that is although the disabled part has not been removed and still forms an integral part of the organism it is wholly or partially useless. As examples of this may be mentioned an extremity paralyzed as a result of a fracture of the spine or severance of a peripheral nerve vicious union in a fracture etc. Finally the disability may be *professional* in the latter case the injured man may be completely unable to perform the work which he did previous to his accident and yet be entirely capable of doing something else.

The degree of functional impairment or disability is expressed in percentage. Under the laws of most European countries the normal healthy organism as a whole is considered as representing 100 estimations as to the degree of impairment resulting from the loss of several fingers a hand vicious union in a fracture etc. are made with this as a standard. Under most of our state laws however specific values are assigned to the various parts of the extremities which leads to evaluation frequently upon a different basis. For example a claimant may present himself with a stiff almost useless wrist the result of a fracture at the lower end of the radius. The arm above the elbow is entirely normal. Under many of our laws the arm from the elbow down would represent 100 and the estimate of functional loss made upon this basis. Naturally however many conditions arise in which the functional capacity

of the body as a whole must be taken as the standard for comparison.

To estimate disability with any degree of exactitude requires a thorough examination and judgment, experience and common sense. The examiner must likewise preserve a thoroughly judicial attitude. Previous to the advent of compensation legislation which is a matter of recent years surgeons were rarely called upon to express an opinion in exact figures as to the degree of disability in any given case. Today it is a matter of daily occurrence. In the beginning with no previous experience to serve as a guide these opinions often represented mere guesses. Today, however, by taking into consideration certain factors which have been found to be important and by considering a case in all its aspects an examiner can arrive at a figure which seems to be approximately correct for practical purposes that such is the case is demonstrated by the fact that any number of independent experienced examiners in reference to a given case will arrive at very nearly the same figure with but slight variation one way or the other.

If the estimation of disability following injury could be reduced to a strictly mathematical basis the problem would be comparatively simple. Several attempts have been made with this object in view but they all leave much to be desired.

Moorhead suggested a standard of end result values based on the three factors of function, union and contour. To function he arbitrarily assigned a value of 60 per cent, to union or healing a value of 20 per cent, and to contour or cosmetic result a value of 20 per cent. Several objections may be urged against this method. The principal one is however that the most important element in the above formula, function, which must be known before the formula can be applied, is the one which we are most interested in determining. And function cannot be determined without taking into consideration union or healing, which forms the second factor in the formula. Consequently we are just as far from a mathematical basis as ever for the estimation of function still remains a matter of personal judgment and experience even though we wish to make use of this suggested plan. Even though this were not true in my opinion the value assigned to contour or cosmetic result is altogether too high.

The method of Kessler makes use of factors which are capable of measurement with some

Moorehead's method of disability estimation

Function	60	Union	20	Contour	20	Total	100
Function	60	Union	20	Contour	20	Total	100
Function	60	Union	20	Contour	20	Total	100

degree of accuracy it is true. These factors are (1) joint movement (2) muscular power and (3) coordination and brain control. But having obtained the measurements the problem is applying them so as to determine correctly the loss of function in a limb as a whole still remains. By assigning certain arbitrary values to the various joints and parts of an extremity a definite figure may be obtained but again the personal factor has entered and in my opinion the result is no more accurate than those obtained by a simple estimation based upon a careful consideration of all the factors present which go to make up the disability. In fact in certain cases the figures arrived at by Kessler's method will be entirely too high. Certain other reasonable objections to it may also be advanced but a full discussion of the method does not come within the scope of this paper.

So far as I know no method has been devised up to the present time into which the personal element does not enter. Consequently none of them give a figure which we can be sure are absolutely reliable in the last analysis. Under such circumstances I believe that an opinion based upon thorough examination, good judgment, common sense and experience is just as valuable as one based upon the application of any arbitrary formula.

As was said previously fractures constitute one of the most frequent of the serious industrial injuries which the general surgeon is called upon to treat. They are likewise one of the most frequent causes of permanent disability, thus giving rise to circumstances in which estimates of the degree of impairment are required. While I do not believe as stated above that the estimation of disabilities even approaches an exact science in a very remote degree or that it ever will or that there are definite rules by which correct figures may be arrived at nevertheless there are certain conditions common to all fractures the presence or absence of which must be established by examination with the object in view when this has been done definite information is obtained upon the basis of which if properly interpreted a reasonably correct estimate can be made.

The evolution of a typical fracture for example one of the extremities may be considered to occupy four stages. The first stage follows immediately after the accident. It is usually short but for various reasons may be prolonged for several days. The fracture is recent, shock is present, must be admitted, the patient may have to be transported some distance en route.

hemorrhage into the tissues may prevent immediate reduction. Under these circumstances any retentive apparatus is merely temporary.

The second stage is that of active treatment. The fracture is now reduced and reduction maintained with suitable permanent retentive apparatus. Open operation if indicated is performed. If the fracture is an open one efforts are made to prevent infection or to treat it if present. The aim of treatment during this stage is to secure as perfect anatomical repair as is possible.

The third stage is the stage of functional convalescence. Bony union is now well advanced and treatment is aimed at promoting the rapid return of normal function.

The fourth stage is that of useful convalescence. In this stage the patient returns to work. Such work is usually light in the beginning, becoming more arduous and heavy as the injured member recovers its capacity for performing its normal functions in connection with the usual occupations of the claimant. Under the best of circumstances this recovery is ultimately complete; ordinarily it happens that a certain degree of permanent incapacity remains.

It is thus to be seen that the aims of treatment in any fracture are twofold: first, in the beginning, anatomical repair as perfect as possible is to be sought for without however at any time losing sight of the second, which is functional restoration. From the point of view of workmen's compensation the latter is the more important. It is also clearly obvious that any estimate of impairment of function or disability to be of any value must be based upon conditions either actual or anticipated at the end of the fourth stage above or when no further improvement is to be expected.

When a fracture is examined the question to be decided is: To what extent if any has the functional or working capacity of the limb been impaired as a result of this fracture? To answer this the examination must be conducted with a view to obtaining all the information possible upon the following points: (1) the condition of the fracture itself; (2) the condition of neighboring and adjacent structures; (3) the effect of each of these upon the other; (4) the effect of all these above factors taken collectively upon the functional efficiency of the member as a whole.

The fourth point cannot be too strongly emphasized. There may be multiple disabilities but each one cannot be estimated separately; what is desired is the functional disability of the limb or portion of a limb taken as a whole, and

not the various disabilities of its muscles, nerves, tendons, etc., though naturally these must have been considered before arriving at the final estimate.

Another factor that of adaptation undoubtedly plays an extremely important part in reducing the ultimate disability from any injury, whether fracture or not. Compensation laws however as a rule do not take it into account; consequently it has been excluded from consideration in this discussion. Its influence is extremely uncertain and hard to evaluate; the power of adaptation varying so greatly in different individuals. However, there is absolutely no doubt that were it reckoned with, our present estimates would be found to be too high.

Turning now to a consideration of the condition of the fracture itself, it is of extreme importance in the first place to determine its exact location in the bone. Perfect coaptation of fragments is much easier to secure in some sites than in others; for example, as a rule a better functional result is secured in fractures of the shaft of a bone than in intra-articular and juxta-articular fractures. In these latter situations perfect coaptation is often hard to obtain while at the same time it is of more importance than in fractures of the shaft. In addition to this, there is always more or less exudate and hemorrhage into the joint; the period of immobilization necessary for union of the fragments greatly hinders absorption of this exudate and adhesions will be formed which will give rise to functional disability. Naturally the early employment of passive motion and massage in the treatment of such fractures will greatly minimize the danger of a stiff joint; nevertheless stiffness and disability sometimes remain after the best possible care, and are the rule in fracture treated by prolonged immobilization as is still frequently the case. Disability in juxta-articular fractures may be the result of exuberant callus leading to a limitation of joint motion.

In fractures of the shafts of certain bones nerves may be injured and it is important that the examination be made with this possibility in mind. Thus in fractures at the upper end of the humerus the circumflex nerve may be implicated; in the middle of the shaft the musculospiral. A fracture at the upper end of the fibula may involve the peroneal.

In the forearm exuberant callus following fracture of one of the bones may be the cause of great functional disability by preventing rotation of the radius about the ulna.

From these brief considerations it is clear that the site of the fracture is an important factor in



estimating the resulting disability. But this is only one of them.

The alignment of the fragments may be poor there may be incomplete apposition or overriding union with angular deviation of the fragments may have taken place the so-called vicious union shortening may be present vicious callus non union pseudarthrosis all these present themselves as possible elements in evaluation.

When either delayed union or non union is present no correct estimate of the permanent disability can be made and one should not be attempted. Both conditions simply mean that the evolution of the fracture is not yet complete consequently the final examination of the case should be postponed until a later date when no further change is to be expected.

A careful differentiation must be made between non union and pseudarthrosis; however most cases of the former are readily amenable to surgical treatment with ultimate bony union such may or may not be true in the latter condition. When the time of consolidation of a fracture is prolonged beyond the time usual for such a fracture the case is considered as one of delayed union when the period of time has been much prolonged and consolidation has not taken place it becomes one of non union. Such cases must be investigated very carefully. The interposition of a strip of muscle or fat between the fractured ends of a bone may delay union indefinitely causing the case to be considered one of peculiar throsis with removal of the cause delay however union may promptly occur. Local or constitutional condition which may give rise to non union must be kept in mind and searched for and their influence established before a diagnosis of pseudarthrosis can be made. Pseudarthrosis is very frequent in the sixth century following substance in gunshot and compound comminuted fracture etc. On the other hand septic infection may definitely delay union. Clinically in pseudarthrosis the affected part presents a high degree of abnormal mobility while pain is entirely absent or less and swelling rarely about it and the kinetic more or less normal in the arm etc. In delayed or non union on the other hand the abnormal mobility is much less pronounced the pain is always present though it may be less pronounced and the kinetic frequently presents a flaccid or evanescent quality with often irregular change. Skinning like is usually however evidence of callus formation in cases of non union in cases of pseudarthrosis no callus is present and the

ends of the fragments are more or less rounded off.

What effect has an existing pseudarthrosis upon the functional efficiency of the affected limb? Naturally under the best of circumstances the disability is considerable the degree however varies somewhat with the situation of the false joint and with the condition of the surrounding structure. The principal consequence of a pseudarthrosis is an insufficient rigidity of the affected part. In the humerus often to a surprising extent this may be overcome during purposeful movements by powerful muscular contraction holding the ends of the fragments together frequently a satisfactory brace may be fitted. Pseudarthrosis of both bones of the forearm is extremely disabling and may at times be equivalent to total functional loss of the member if it involves but one bone the result may or may not be serious. In regard to the radius the power of pronation and supination is lost the disability is great if there is likewise associated outward deviation of the hand due to injury in the neighborhood of the radial epiphysis; the disability is still greater. Under such circumstances the grip of the fingers is extremely weak. Pseudarthrosis in the ulna is much less disabling.

When we consider the lower extremity we find that pseudarthroses here are of much greater consequence. The principal quality of the leg is stability and its amount of muscular contractility can furnish sufficient stability for weight bearing apparatus like a whole of some assistance nevertheless leaves much to be desired. Pseudarthroses of the femur and tibia may at times be sufficiently disabling as to require amputation of the leg fortunately the former is rare. Pseudarthrosis of the fibula alone however may be present with very little diminution in the function of the leg provided that the external malleolus is intact otherwise there will be marked outward deviation of the foot with consequent increase in disability.

In all cases of pseudarthrosis the condition of associated structures in the limb is of the utmost importance interference with nerve or muscle function naturally greatly augments the degree of disability.

Union of a fracture may occur with the fragments in such a defective position that the function of a part are seriously interfered with. Such may be the result of angulation overhanging or some other variety of incomplete reduction. It may also be the result of too early resumption of functional activity before sufficient bone has

formed in the callus. The effects of vicious union are as a rule least marked in the humerus. Here union of nerve function is interfered with or shortening is extreme. Considerable degrees of deformity are entirely compatible with perfect or almost perfect function of the arm. Such is not the case in the forearm. Angular deviation of either bone may seriously interfere with if not entirely abolish the movements of pronation and supination. In addition if pronounced deviation of the hand to the affected side may be produced leading to weakening of the grip and serious disability. Angular deviation of both bones may give rise to an impairment of function amounting practically in extreme cases to complete loss of the hand. Deformity at the lower end of the radius gives rise to a high degree of disability by interfering with the movements of flexion and extension at the wrist. If this is associated with tendon adhesions stiffness of the fingers etc. is so often the case the disability reaches an extreme grade and the hand is practically useless.

Vicious union occurring in the lower extremity may likewise have serious consequences. Shortening which is ordinarily of least importance will be discussed later. Angular deviation however unless extremely slight cannot fail to cause some disturbance of the axis of weight bearing. In the leg and foot the arrangement of the bones their mutual relationships the strength of ligaments the direction of muscular pull in fact the entire structure has been developed for the purpose of supporting the weight of the body and for locomotion under normal conditions and can only function at maximum efficiency when the line of weight bearing falls in its normal axis. Any deviation in this normal axis sets up numerous abnormal strains and stresses in the entire extremity including frequently the pelvis and spinal column. Such a condition cannot but be productive of more or less marked loss of functional efficiency. In the milder grades this may be manifested only as pain resulting from tired and over-stretched muscles and ligaments. Upon the resumption of activity after a period of rest such pain may not immediately make itself felt but after a varying period of use it comes on and persists constituting a marked disability in a man whose work compels him to be constantly on his feet. In all such cases the various forces present in the extremity while it is in use should be carefully investigated. While pain being a purely subjective manifestation is undoubtedly often simulated and more frequently exaggerated nevertheless in many of these cases a careful study will often reveal a physical basis for it.

Marked angulation of the femur fractures in the neighborhood of the knee and ankle joints with union of fragments in poor position particularly fractures of one or both malleoli fractures of the tibial shaft fractures of the os calcis or astragalus fractures of the metatarsals—all these various forms of fracture giving rise to static disturbances or by mechanical interference with the functions of joints may occasion disabilities which are usually considerable and which may occasionally be equivalent to practical loss of the member.

Fortunately many of these conditions are today amenable to surgical treatment such being the case no estimate of permanent disability should be made in these cases until it is certain that no further improvement in the condition present can be hoped for from expert surgical procedure.

Another factor in evaluation which must be considered is shortening. As stated above it has not an importance of the first order. It is due to angulation overriding impaction or extensive loss of substance such as occurs in osteomyelitis or gunshot wounds. It is usually not marked although occasionally it may be enormous under which circumstances it becomes a consideration of prime importance. In the humerus it need enter but little into our estimate in the forearm much loss of substance of one bone presents an absolute obstacle to union in that bone and we have developed a pseudarthrosis. Under certain circumstances union with shortening of one bone may give rise to deviation of the hand to one side or the other thus occasioning permanent disability. Shortening of both bones of the forearm as a rule is due to union with overriding of the fragments in such a case the disability present is the result of factors other than the shortening such as loss of pronation and supination tendon adhesions nerve pressure etc.

In the lower extremity shortening of 3 to 4 centimeters is usually readily compensated for by tilting the pelvis and does not constitute a disability. As a matter of fact there is frequently a normal variation present in the length of the two legs. Above 4 cm. the injured person limps more or less but with a solid extremity good alignment and vigorous muscular development claudication does not constitute a very serious disability for the average workman. Naturally with extreme degrees of shortening the disability is correspondingly greater.

Abnormalities of the callus following a fracture are not infrequently the cause of permanent disability. The callus may be painful from

inclusion in it of nerve fibers or frequently for no reason at all that we are able to ascertain. And this painful condition may not respond to any treatment. The callus may be too large either from overproduction in the first place or from failure of absorption—persistent callus. Infection is an important element in causing overproduction. When too large the callus may interfere with the normal action of muscles and tendons occasion difficulty in wearing shoes and sometimes give rise to ulcerations of the overlying skin. Nerves may be included in it with abolition of their function and peripheral paralysis. In the forearm it may interfere with the normal movement of one bone on the other and not infrequently leads to a fusion of the two bones.

Chronic suppurative due to osteomyelitis is not a direct factor in the evaluation of permanent disability when such a condition is present it represents but one stage in the evolution of the fracture. Under such circumstances no estimate can be made with any degree of exactness and none should be attempted the final examination and a decision should be postponed until such time when no further treatment of any kind is indicated and no further change in the condition of the injured member is to be expected.

All of these various pathological conditions which have just been described arise directly from and are intimately connected with the healing of the fracture itself. Any or all of them are capable of producing varying degrees of permanent disability consequently in any given case the effects of the presence of one or several of them their degree of severity etc. all must be taken into consideration in the final estimate of loss of function. But having done this the list of factors giving rise to permanent disability is not yet complete. There still remain for discussion pathological conditions giving rise to disability arising as a result of a fracture but affecting tissues and structure other than the bone itself such as nerves muscles joints and circulatory channel.

Disturbances of nerve function may be manifested either subjectively or objectively.

The principal if not the only subjective manifestation is pain. A certain amount of pain and soreness is so frequent following fractures that it may almost be said to be a constant finding. As a rule however it rapidly disappears following resumption of normal activity to recur perhaps to some slight extent during damp or changeable weather. Such pain may constitute an inconvenience it is true but it is not a disability. On the other hand cases are often seen in which the

pain is very severe and may persist for years. Under these circumstances a real disability is produced. Such pain is often due to nerve compression by callus to the inclusion of nerve fiber in a healed callus or to factors of which we are ignorant at any rate no definite cause for it can be discovered. As a rule pain in the lower extremity gives rise to more disability than pain in the upper. In all cases of alleged disability from pain extreme care must be taken not to assign to it undue importance. Pain is easily simulated and there is no standard by which it may be appreciated also there is an unconscious tendency common to practically all human beings to exaggerate it in evaluating pain therefore the things should be taken into account. On the other hand it should never be lost sight of that severe persistent pain is not infrequently present particularly following fractures of the leg and that definite sometimes marked disability may result from it.

From an objective standpoint we may have definite paralysis as a result of nerve injuries. When present these are a very important factor in the determination of disabilities. Disturbance of nerve function may be the result of direct injury at the time of the fracture or may occur secondarily from pressure by or involvement of the nerve in the callus. Minor degrees of functional nerve disturbance are frequently present and are manifested by trophic disturbance cutaneous anesthesia etc. The delicate gloved condition of the skin of the hand and fingers which is so commonly observed after fractures of the forearm and wrist is undoubtedly due to interference with nerve function. As a result in cases of severe nerve injury often presents a difficult problem on account of the uncertain prognosis it may not infrequently be necessary to allow several months to elapse to allow for possible regeneration before undertaking a final estimate. Many cases are amenable to surgical treatment while others are not. In view of all this extremely careful and painstaking study of all cases showing nerve involvement is necessary.

Closely associated with nerve injury is muscular atrophy. To some extent it is constantly present following every fracture. While it is due from prolonged immobilization is commonly assigned as a cause for it in the absence of definite nerve injury it may well be that certain other factors are also active in every case. The chief of these is the so-called trophic disturbance due probably to obscure disturbances of nerve function but such are not due to direct trauma from the

fracture or to any of the other conditions mentioned above is causing nerve injury. Whatever the cause the degree of muscular atrophy must always be taken into account in estimating disability.

To determine the degree of atrophy comparative mensuration is ordinarily employed and furnishes sufficient information for our purpose. But in taking the measurements care must be exercised and the sources of error and fallacies of the method kept clearly in mind. For example the thigh being conical is difficult to measure correctly unless care is taken to have both legs in the same position and equally relaxed and unless the measurements are taken at exactly corresponding points on each extremity. On the other hand the calf is much easier to measure because it presents an easily accessible maximum circumference the same is true of the upper arm while the forearm again presents the same difficulty as the thigh. Assuming that correct measurements have been taken however caution must still be exercised in drawing conclusions muscular development is frequently asymmetric. The right arm is normally larger in right handed individuals as is well known and the reverse is true of those who are left handed the calves of the legs are often unequal in size and it is some times the right sometimes the left which is larger finally certain occupations may give rise to work hypertrophy of muscles which are normally not overdeveloped in the average individual. Overriding of fragments and oedema may also add to the uncertainty. Fortunately much assistance may be gained from palpation in a normal individual the muscular masses while they may be unequal in volume are equal in consistence softness and flabbiness certainly indicate atrophy and the sensation furnished by such muscles is almost characteristic. In certain cases particularly those in which atrophy is extensive electrical testing of the affected muscles is often of value.

The condition of the neighboring articulations following a fracture must always be a subject of careful investigation. Complete ankylosis while it does occur is fortunately rare partial ankylosis is more common and varying degrees of stiffness are present in practically every case unless the conditions of treatment have been ideal. All of the minor forms of joint disturbance and some of the more severe ones are usually due to prolonged immobilization others particularly the graver types result from the relation of the fracture to the joint giving rise to injuries of articular cartilages imperfect reduction of fragments

constituting actual mechanical hindrance to joint motion etc. Limitation of joint motion may also result from scar contraction following compound fractures. Finally all of the periarticular structures may be the seat of a pathological process giving rise to a condition of so called chronic arthropathy. The stiff and painful shoulder so frequently seen following trauma to this joint particularly in middle aged and elderly patients is a typical example of such a condition. Unless carefully treated with early massage and passive motion fractures in the neighborhood of the wrist joint are particularly liable to leave the wrist and hand disabled since the intimately associated flexor and extensor tendons share largely in the pathological process.

In cases of complete ankylosis the degree of disability depends first upon the decrease of functional efficiency due to loss of motion in the joint and second which is the most important factor upon the angle of fixation. The latter may determine the question as to whether the functional loss is 10 per cent or 100 per cent. In cases of partial ankylosis the arc of mobility retained whether favorable or unfavorable is the deciding factor.

All cases of limitation of motion and of partial ankylosis are benefited by the resumption of normal activity so far as possible consequently no final estimate can be made before use of the extremity has been undertaken and no further improvement is manifest. It is often astonishing to what a degree limitation of motion will disappear naturally such is not the case if the limitation is due to a mechanical obstacle.

Circulatory disturbances are frequently seen after fractures. After removal of a cast the extremity commonly becomes somewhat cyanotic and oedematous for a time particularly the leg with use however in most cases this rapidly disappears. But we sometimes see cases in which it persists. Under such circumstances it may be due to phlebitis or to other factors the nature of which is obscure. Occasionally this oedema becomes hard and firm and very painful the prognosis here is bad the condition is more or less permanent it gives rise to considerable impairment of function and must be considered an important factor in estimating permanent disability.

These diverse variations from the normal which have just been discussed the concomitants complications and sequelae of fractures represent the positive elements which must be considered in estimating the degree of functional loss. Disability is conditioned by them. It seems self

evident in general that the more closely the final result following fractures approaches the anatomical normal the better the functional result. The question is summed up briefly and excellently by Llewellyn and Jones as follows:

1. A close interdependence obtains between the character of the anatomical union and the ultimate functional results.

In a simple fracture given good alignment sound union and the absence of complications such is generally correlated with excellent functional results in 90 per cent of cases.

3. With faulty alignment the ultimate functional efficiency of the limb is usually impaired and thus in general in direct ratio to the mechanical imperfections thereof.

So far I have attempted in this paper to discuss only those more or less definite tangible and principally physical conditions associated with fractures the effects of which on the ultimate functional efficiency of the part are susceptible of measurement or estimation with an approximate degree of accuracy. Other factors are undoubtedly present to some extent in every case and influence the ultimate result but their effects vary so much in each individual and are in general so intangible that as a rule they must be disregarded in estimating disability. A few examples may make this clearer.

The psychic attitude of the patient plays an undeniable rôle in his complete recovery. I am not here referring to cases of simulation or malingering or to the traumatic neuritis. But some cases seem to have a tendency in themselves and are unable to make a proper effort to recover function even when the physical impairment is relatively slight and this is true in cases where no compensation is expected.

Another factor is the personal efficiency of

skill. We not infrequently see patients who have regained functional use of a member to a surprising degree in spite of what is apparently an extremely grave physical handicap. On the other hand patients are seen in whom the return of function is far from being what we should expect and this in spite of their best efforts.

Closely related to the factor last mentioned is that of adaptation or accommodation of the individual to the changed conditions following his fracture which was briefly mentioned above. This undoubtedly plays a large rôle in every case nevertheless the degree to which it will bring about improvement cannot be anticipated nor estimated.

The age of the patient is also of importance. Recovery from fractures in those past middle life is undoubtedly slower and less complete as a rule but even this is subject to individual variation.

In all cases it must be clear that no opinion can be based on anatomical findings alone. While in general as was stated above anatomical and functional results are usually closely interdependent yet this does not hold true in every case and it is upon the basis of functional efficiency that we must base our estimate. In all cases we cannot confine our examination to the fracture alone and base our opinion upon its condition. The condition of all the parts of the affected member must be taken into consideration. If the lesions are multiple also we cannot evaluate them separately assigning a certain percentage to the fracture another percentage to loss of motion in a joint etc. The sum of figures obtained in this way does not represent the actual disability present but it is not infrequent to see an attempt made to arrive at it in this way. In every case the estimate is to be made of the loss of function of the limb as a whole and not upon that of its various parts.

Possibilities of functional efficiency of

## SPINAL ANÆSTHESIA

By C. B. SCHUTZ, M.D., PHILADELPHIA  
La. I. H. p. tal

IT is obviously true that the ideal anæsthesia is local anæsthesia and it is equally true and obvious that the ideal local anæsthetic has not as yet been found. When it is found half of our surgical worries will be dispelled. At present we have at our command many different methods of administering local anæsthesia and many different agents for its use. Most of them are acceptable but no one of them is entirely satisfactory. Spinal anæsthesia we believe has its place in this group and in selected cases according to our present standards of comparison is as nearly satisfactory as any of the available methods. As in most innovations in surgery each has its loyal advocate—a loyalty that in some instances proves dangerous because of its blindness. In the Lankenau Clinic we began the use of spinal anæsthesia with the hope of giving the patient the benefit of its avowed advantages. We have continued its use for over 2 years with a realization of its dangers and its disadvantages but with a recognition of its distinct advantages. It is the purpose of this paper to present the facts of spinal anæsthesia as we have learned them from our experience of over 2,000 cases. Though we have used stovaine, novocain, and scurocaine our largest experience has been with apothesine and it is this drug that has been used in all of the cases with which this report is concerned.

Spinal anæsthesia has been so widely used that it would seem trite to speak of its advantages and its indications were it not for the fact that one is so frequently questioned as to whether or not it is an anæsthetic of sufficient merit, safety, and advantage over general anæsthesia to justify its use. We are of the decided opinion that spinal anæsthesia is the anæsthetic of choice in selected cases with the emphasis on selected cases. Just what types of cases we consider as belonging to these selected cases will be discussed below.

Apothesine produces a paralysis of the sensory and motor nerves involved in the area of anæsthesia. It is essentially a peripheral nerve paralysis and has certain distinct advantages over general anæsthesia. It abolishes pain but unlike general anæsthesia the pain is abolished by producing a peripheral block to sensory stimuli thus giving true anoci-association. This may be a factor in the lessened amount of shock shown by patients so anesthetized. Its greatest advantage

however and one of sufficient merit to justify its use is the perfect relaxation which it produces. The relaxation is almost cadaveric and thus allows the operator to proceed with the minimum of technical difficulty—a distinct advantage to the patient as well as to the surgeon no matter how skilled the latter may be. For example we attribute our low mortality of per cent in acute appendicitis partly to the fact that this form of anæsthesia is used in so many of these cases for it allows good exposure with delicate retraction. As the effect of the anæsthesia subsides this relaxation disappears but its duration is sufficient to permit almost any abdominal operation. Its efficient effects sometimes last from 45 minutes to an hour—although it is seldom satisfactory for a longer period.

The safety of this form of anæsthesia has in our experience been absolute. We have never had a mortality which could be attributed directly to the anæsthetic and we have never seen a single sequela which has warranted anything more than transitory concern. We do not however consider it harmless. Every case in which this anæsthesia is administered is carefully selected, carefully watched, and the dose of the drug is carefully calculated and carefully given. It speaks well for the safety of the anæsthetic when we state that in this clinic the interne who administers it is changed every three months and except for practice on the cadaver and by observing others has had no previous experience.

## INDICATIONS

There are certain types of cases which to our mind demand spinal anæsthesia others in which it may be indicated and still others in which it is definitely contraindicated. In the past years our postoperative pneumonia mortality has been reduced to a very low figure and although there are other factors involved such as pre-operative treatment and the comparative exclusion of ether anæsthesia we attribute a large part of this to our practice of using spinal anæsthesia in all cases having pulmonary symptoms in which there is no definite contraindication to spinal anæsthesia. Practically every case of intestinal obstruction is operated upon under this anæsthesia. In this type of case the technical difficulties are reduced to their lowest degree by the complete

relaxation produced by the anesthesia. Furthermore the tendency of the dilated intestines to fall away from the anterior abdominal wall practically abolishes the usual difficulty in replacing the eviscerated intestines and aids in decreasing the amount of shock following this operation. *The technical difficulties which are to be expected in cases of large abdominal tumors secondary operation where the viscera are bound up by adhesions thick abdominal walls and especially in difficult kidney operations almost invariably disappear when spinal anesthesia is used.* Abdominal pus cases demand spinal anesthesia even when the blood pressure is lower than the accepted minimum in other types of cases. Here the lute relaxation is not only convenient to the surgeon but it is of vital importance to the patient. Every added straining used in obtaining the necessary exposure vastly increases the danger of spreading pus which nature has taken so much trouble to localize and wall off. This cannot be overemphasized for to get good results in the e cases one must handle the tissues lovingly and this is well nigh impossible under gas anesthesia and often difficult under ether.

There are certain cases in which operation can be done with comparative ease under gas or ether anesthesia but better results are had if operation is done under spinal anesthesia. These cases include those in which there is evidence of renal insufficiency or dysfunction as shown by a high blood urea, albumin and casts in the urine. It is of course well known that ether causes destruction of renal tissue and that traces of albumin and casts may be found in the postoperative urine of patients who have been operated under gas anesthesia. Thus renal change following gas or ether in the urine is of little moment but when there is already some kidney deficiency before operation it becomes of greater importance. Our experience has been that cases with blood urea is above normal or showing other evidence of renal upset such as albumin casts etc. in the urine are much less harmed by an operation under spinal than under any form of general anesthesia. Cases with high blood pressure present a difficult problem for any operation and for any anesthesia. We are not particularly enthusiastic about spinal anesthesia in the e cases but we do not hesitate in fact we prefer to use it if there is no decided evidence of cardiac weakness. We have found that these patients feel a great deal better with it than with ether and certainly better than with gas.

Spinal anesthesia is given not only in the difficult cases but in those in which a prolonged surgical procedure is necessary. They practically always do better than when a general anesthetic is given because postoperative shock is reduced. The fact that the spinal anesthesia usually wears off before the operation is completed offers no objection to its use for as the anesthetic wears off its effect on gas and oxygen may be given and the operation completed without discomfort to the patient or to the surgeon.

The one definite contraindication to spinal anesthesia is a low systolic blood pressure. The accepted safe minimum systolic blood pressure is usually given as 100 but we have frequently used spinal anesthesia in cases in which the systolic blood pressure was between 90 and 95 and have not seen any particular tendency toward more pronounced immediate untoward symptoms of the anesthesia than in the usual case. It is however safer for the inexperienced surgeon to consider a systolic pressure of 100 millimeters as a minimum of safety. It is not always possible to judge how great a fall in systolic pressure will follow the anesthesia and it requires some experience to calculate the proper dosage and to estimate the proper amount of drug used in the injection of the drug. It is well to remember also that it is the systolic blood pressure at the time of operation that is of importance. A blood pressure estimate taken days or weeks before operation cannot serve as a criterion.

There can be no doubt that the anesthetic puts a strain upon the heart for the sudden fall in blood pressure requires an active and efficient compensatory cardiovascular system. As there is somewhat more strain under this anesthesia than under gas or ether we seldom give spinal anesthesia where there is evidence of low cardiac reserve. For some time we have felt an increasing conviction that the highly nervous apprehensive patient is not a suitable subject for the form of anesthesia if it is used alone. The mental chaos that these patients make for themselves offsets many of the good effects of the anesthetic. However in the type of patient spinal anesthesia in conjunction with a very light gas anesthesia approaches the ideal. The combination provides perfect relaxation complete sensory paralysis in the operative field with just sufficient general anesthesia to paralyze the frontal lobes. At the completion of the operation a few inhalations of oxygen restore consciousness and relieve the patient of the distressing experience of coming out of the general anesthesia furthermore liquid can be taken by mouth much sooner than

after general anesthesia—trifles which often rise to importance in this type of patient.

In the aged and in the young patient the anesthesia must be given with care. We have never given it to a patient younger than 14 years. We frequently give it to patients beyond 80 years of age but we are always guided by the general condition of the individual and invariably proceed with caution. In the very old patient we use it most frequently for amputations of the lower extremity for such conditions as emile gangrene. In these patients the minimum dose often suffices and whether or not the reduction of the postoperative shock should be ascribed to anociascroton depends upon one's opinion of the theory. In some of these patients the presence of an old osteoarthritis involving the lumbar vertebrae offers difficulty in making a clean and smooth spinal puncture and it is therefore occasionally difficult to obtain a good take. But the presence of this sequela of arthritis is not in itself a contra-indication to spinal anesthesia. In prostatic bladder and uterine operations in operations on the sigmoid and in carcinomatous cases in which extensive bowel resection is required this form of anesthesia with the exception already referred to is the one of choice.

#### TYPE OF DRUG USED

As before stated our experience has been largest in the use of apothesine. We have upon occasions used stovaine, novocain and scurocaine but have always returned to apothesine as a more favorable drug. We realize that novocain is more widely used than apothesine and with good results and therefore must conclude that novocain and apothesine are about equally efficient. It is not the purpose of this paper to advocate apothesine in favor of novocain but merely to record our experience with the latter drug. We have discarded stovaine because it is too toxic to be used with safety. Scurocaine has the advantage over apothesine in that it does not require the withdrawal of spinal fluid and that it can be used above the umbilical line but it has the disadvantage for lower abdominal surgery in that two injections are required.

Apothesine presents two immediate untoward results. The first and the more serious is a fall in the systolic blood pressure with slow, shallow respirations and a weakened pulse. To the inexperienced operator the effect may sometimes be alarming but we have never found them unmanageable. The fall in the systolic pressure which rarely is as great as twenty points is due to the direct effect of the drug in causing a paralysis of

the splanchnic nerves—including the vasoconstrictors in this region with a consequent pooling of the blood in the splanchnic vessels. This is produced with such rapidity that the remaining portion of the cardiovascular system is unable to accommodate itself immediately to the sudden loss of circulating blood and the usual fall in the systolic pressure results. Generally however there is rapid accommodation on the part of the cardiovascular system so that the only aid that is needed to produce sufficient if not complete accommodation is the Trendelenburg position. In fact after the injection of the drug the patients are immediately placed in the Trendelenburg position without waiting for any further indication. Later when the accommodation has been established the head may with safety be raised slowly to the desired level. However if the patient's head is raised during the course of the operation he should be most carefully watched for sometimes the accommodation is not sufficient to offset this added burden. If the Trendelenburg position is not sufficient an understanding of the cause of the fall in blood pressure with its resulting syncope suggests the logical use of adrenalin and caffeine (usually in doses of 0.05 minims of the former and 2 grains of the latter) and if the condition warrants it the intravenous injection of saline and glucose. All of our cases readily recovered under this form of treatment but no time can be lost in deciding upon this treatment. One must not wait to see how the patient will be in a few minutes. Treatment must be prompt. We have a hypodermic of adrenalin and caffeine ready for instant use and are always prepared for intravenous injection.

The other immediate untoward result and the one that is more frequently seen is vomiting. It is not serious but it is annoying to the patient and to the operator. Just what the exact mechanism of this is we have not been able to determine to our complete satisfaction. Usually the patient does not actually vomit although he complains of severe nausea and gives every evidence of the vomiting reflex. It is perhaps better to call it a severe retching. It seems to be an admixture of both the toxic effect of the drug and the result of the upset in the cerebrospinal equilibrium due to the withdrawal of spinal fluid. It may be significant that it occurs more frequently in cases in which the injection has been high or in which a large dose has been given. It is usually controlled by inhalation of pure oxygen and never persists throughout the operation.

Of the several more remote ill effects of the anesthesia the most frequent one is headache



Headache following apothesine is peculiar in the fact that it is postural. By this we mean that the patient complains very little if at all as long as he is kept in the recumbent position. But as soon as his head is raised the dull heavy generalized headache sets in. A return to the recumbent position brings almost immediate relief. The cause of this headache is not as yet clear but we are of the opinion that it has not so much to do with the toxic effect of the drug as with the disturbed cerebrospinal equilibrium resulting from the withdrawal of spinal fluid at the time of the administration of the anesthetic. We have however seen it occur after the administration of scurocaine in which there was no withdrawal of spinal fluid. It perhaps occurs more frequently in cases in which a fall in blood pressure was especially marked at the time of operation but it is also occasionally seen in cases in which there has been no especial immediate untoward effect of the drug.

This latter fact sometimes has confused an understanding of the exact etiological factor in the headache. We believe that fewer headaches would follow the anæsthesia if the withdrawal of spinal fluid could be eliminated. In the use of apothesine however the withdrawal of spinal fluid is essential for the production of a satisfactory anæsthesia. The same applies to novocain. Of course the purpose of withdrawing the fluid is to produce a diffusion of the drug over a wide area in the spinal canal so that a correspondingly wide area is anesthetized. This allows of a single injection in all abdominal operations whereas two injections of scurocaine are required in most operations. The same amount of spinal fluid is withdrawn in each administration regardless of the dose or of the area it is desired to anesthetize. In our experience the headache following the anæsthetic has not been of sufficient moment to offset the good effects of the anæsthesia. The headache responds best to caffeine by mouth and in the vast majority of cases subsides in a few days but occasionally may be quite troublesome and last as long as a week rarely more than a week. It is never been severe enough to delay the convalescence from the operation *per se*. We have never seen these severe headaches immediately following the withdrawal of the spinal fluid that some authors speak of. This may be either a coincidence or due to the fact that we have usually withdrawn the fluid very slowly. Whatever explanation for the headache is given and however successfully it is treated it nevertheless remains the most frequent and the most troublesome ill effect of apothesine and the last. In our experi-

ence it occurs in approximately 1 out of every 15 cases.

The effect of the drug upon the motor nerves not infrequently produces a transient paralysis of the sphincter ani or of the vesical sphincter or the bladder musculature or both of the latter. This is always of short duration and requires no treatment other than an occasional catheterization if there is retention of urine. Catheterization is required more frequently after spinal anæsthesia than after general anæsthesia.

Occasionally the effect of the anæsthetic on the sensory nerves persists for a short time as paresthesias in the lower limbs and a sense of numbness in the various segmental distributions of the sensory nerves. Very rarely indeed does the patient complain of pain referred along the course of the sciatic nerve. This has occurred in only three of our series of cases and has never been anything more than a transient complaint although some patients are psychically so affected that every ache and pain within reach of the site of the injection is attributed directly to the anæsthesia. This is to be expected and to be treated as the case demands.

#### TECHNIQUE OF APOTHESEIN ANÆSTHESIA

Apothesine is chemically the hydrochloride of diethyl amino propyl cinnamate. It is obtained in the form of a white powder.

The dose of apothesine in the spinal anæsthesia is 0.01 grms (grains  $\frac{1}{6}$ ) for each 15 pounds of body weight the minimum dose being 0.7 grams and the maximum 0.1 grams. In preparation for the injection the maximum dose of 0.12 grams of the powder is placed in a small sterile bottle with a cork stopper. The bottle containing the powder is stoppered tightly and sterilized for 1 hour at a dry temperature of 60 degrees centigrade. From each group of bottles so sterilized a culture is made of one or two and the remaining bottles are stoppered tightly and dipped in paraffin. The drug is then ready for use. If it has not been over sterilized it will not lose its potency with age.

In making the injection the technique is the same as that used in making any ordinary spinal puncture. The patient is most conveniently placed in a sitting posture and bent forward by an assistant so as to produce a convexity of the lumbar spine and to increase the space between the vertebrae. The spine must be as relaxed as possible—no contraction difficult to obtain in the excited patient. This makes it much easier cleanly and smoothly to enter the spinal canal. After painting the skin over the proposed site of

the injection with iodine and touching the area with novocain to obviate any pain due to the insertion of the needle the needle is placed exactly in the midline and is then pushed slowly and steadily forward and slightly upward. If bone is encountered the needle is slightly withdrawn and again pushed forward at an angle sufficiently varied from the first to miss both the vertebrae. The needle must enter the spinal canal exactly in the midline for otherwise even though spinal fluid is obtained some of the drug will be in filtrated into the surrounding tissue and a good take will not be obtained. When the spinal canal has been entered 10 cubic centimeters of fluid are routinely withdrawn. The spinal fluid is allowed to drip slowly through the needle into a medicine glass. As soon as 5 cubic centimeters have been collected this is drawn up into a hypodermic syringe and then mixed with the sterilized 0.1 gram of apothesine which has been previously placed in a small sterile bottle. Great care must be taken to assure the complete dissolution of the drug otherwise the results will not be good. The dose is then calculated as follows:

The 2 cubic centimeters of spinal fluid is withdrawn with its dissolved apothesine from the bottle by means of a small syringe calibrated to minims. 2½ minims of this solution is allowed for each 15 pounds of body weight as each 2 minims will contain 0.01 gram of apothesine. Anything above the required amount is discarded.

This method of calibration is not an absolute one but is influenced more or less by the general physical and physiological status of each individual patient. Robust patients require larger doses than patients of the same weight but of less general physical stamina. It has also been found that when operations are performed on the upper abdomen and a relatively low injection is made a larger dose than that calibrated by the above method is necessary for a complete take. Conversely in cases in which the site of operation is in the lower abdomen or in patients of lowered general resistance smaller doses are not only sufficient but advisable. How great a deviation from the prescribed rule must be made in each instance is a matter requiring some experience. It is decidedly better to err on the side of conservatism.

While preparing the dose of the drug the spinal fluid is allowed to drop into the medicine glass until it measures 8 cubic centimeters when the obturator is placed in the needle so as to prevent the escape of any more spinal fluid. The dose of the drug contained in the hypodermic syringe is then placed into the 8 cubic centimeters of spinal

fluid in the medicine glass and the former well mixed with the latter by repeatedly drawing the solution into the syringe. A long large bore needle is then attached to a 10 cubic centimeter syringe and the entire quantity of the solution drawn up into the 10 cubic centimeter syringe care being taken that every drop of the solution is transferred from the medicine glass to the syringe. All air bubbles are then excluded from the syringe without losing any of the solution.

This needle is then thrown aside and the syringe fitted into the needle that has been allowed to remain in the spinal canal. After first making sure that the connection between the syringe and needle is secure and after slightly withdrawing the piston of the syringe to show that the point of the needle is still free in the spinal canal the solution is injected. The amount of pressure used in this injection depends upon the amount of diffusion of the drug that is desired. For operations in the lower abdomen the amount of pressure is not of so much importance but for those in the upper abdomen it may be the deciding factor in obtaining a take or a failure. One must learn from experience just what pressure to use in each instance. Suffice it to say that high pressure is never necessary and is always inadvisable. The injection is made slowly and steadily whether or not the solution is mixed with the free spinal fluid by repeatedly withdrawing and re-injecting the solution depends upon the amount of diffusion desired. Some authors have advised against it because of the danger of producing a diffusion greater than that desired. Formerly we used this routinely for all operations in the upper abdomen but at that time we were making all of our injections in the fourth lumbar space. More recently we have obtained better results in operations in the upper abdomen by making high injections (second lumbar space) and using a relatively low pressure. We do not believe that the results of withdrawing larger amounts of spinal fluid (over 10 cubic centimeters) in order to obtain wider diffusion of the drug are of sufficient merit to offset the added danger.

At the completion of the injection the needle is quickly withdrawn and the puncture wound covered with collodion. The patient is then placed in the Trendelenburg position. Better results are obtained if 4 or 5 minutes are allowed to elapse before the operation is begun but we pay no particular attention to this having repeatedly demonstrated that the operation can be begun almost immediately with satisfactory results.

All patients are routinely given pure oxygen through a rubber tube placed in one nostril.

This is the most efficient agent in controlling the severe retching and nausea which often follow the anæsthesia.

#### TREATMENT OF UNDESIRABLE SYMPTOMS

There are three methods of treatment used in the control of the immediate ill effects of the anæsthetic. As before stated these symptoms are all due primarily to a fall in the systolic blood pressure. The treatment is therefore directed to the correction of this change. For the minor symptoms the Trendelenburg position often suffices, but if this does not correct the symptoms a hypodermic of adrenalin and caffeine should be given. As a rule we give 5 minims of adrenalin and 0.2 gram of caffeine. If in a reasonable time this is not followed by improvement an intra-venous infusion of saline and glucose is given. The amount of the infusion varies with the patient and the severity of the symptoms, but as a rule we give 1000 cubic centimeters of saline and 50 grams of glucose. We have never as yet seen a patient fail to respond to this type of treatment and it is seldom indeed that the severity of the symptoms demands the infusion. Patients showing these immediate reactions are carefully watched for the succeeding 12 hours. The foot of the bed is kept elevated and hypodermic injections of caffeine and adrenalin are given as indicated. By the end of 12 hours practically all patients show a very decided improvement and with this the routine postoperative treatment proceeds as usual, the only difference being that water by mouth can be given at an earlier period than in cases in which a general anæsthetic is given.

#### REPORT OF CASES

Over a period dating from March 2, 1914 to March 22, 1917 inclusive 51 cases operated upon in this clinic received apothesine anæsthesia. Of these all but 57 were regarded as takes, i.e. the anæsthetic produced anæsthesia and relaxation without the aid of a general anæsthetic. In these 57 cases the anæsthetic was not sufficient to produce the desired relaxation and a general anæsthetic had to be given before the operation was begun. There was a certain percentage of cases in which gas and oxygen was given for various reasons: (1) to allay the psychic excitement of the patient; (2) to prolong the anæsthesia when the operation extended over a considerable period of time and the anæsthetic showed signs of wearing off before the completion of the operation; (3) to control especially severe retching which has failed to respond readily to inhalation of oxygen.

An infusion of glucose and saline was found necessary in approximately two out of every one hundred patients and an injection of caffeine and adrenalin was given in about one out of every eight cases receiving spinal anæsthesia. Vomiting or retching occurred in practically every case at some time during the course of the operation. Usually this was easily controlled by inhalations of oxygen. In no case was there a mortality attributed to the effect of the anæsthesia.

Of the other sequelæ of the anæsthesia such as incontinence of urine and feces, paræsthesias of the leg, no definite record was kept, but we know that they were common sequelæ and that they all recovered spontaneously. We have had three patients in this series who complained of pain along the course of the sciatic nerve for from 1 to 4 weeks after the operation and in the absence of any other demonstrable cause for this symptom we have been obliged to consider it as being in some way due to the use of spinal anæsthesia.

Our experience with apothesine has naturally become more satisfactory as our practical knowledge of it has increased. We have gained much by carefully searching for the causes of failure in unsatisfactory cases. In the great majority we have found that this was due to one of three things:

1. Occasionally a smaller dose of the drug was injected into the spinal canal than was calculated. This was because the anæsthetic failed to make sure that all of the apothesine was dissolved before making the injection. The drug is some times in the form of small granules which though high in potency dissolve slowly. It is only too easy to fail to allow sufficient time for these granules to dissolve as they form a very small part of the powder and may therefore be overlooked. The bottle containing the solution should be held up to the light and frequently shaken in order to make sure of a complete dissolution of the drug.

2. The introduction of the needle into the spinal canal was not made cleanly and smoothly. If the point of the needle does not lie free in the spinal canal a certain portion of the injected drug will be infiltrated into the surrounding tissues.

3. The mistake of selecting a highly neurotic patient for the anæsthetic. This type of patient has given us the greatest amount of trouble with the sequelæ of the anæsthetic such as headache. Why this is true is difficult to understand but it is a fact that these patients do better under general anæsthesia. In

operations on the upper abdomen the anæsthetic is not so satisfactory as in those in the lower abdomen but its efficiency is well marked in enough cases to justify its use. We have had better results in these cases with high injections (second lumbar space) than with low injections and although there is greater tendency to retching at the time of operation there are no sequelæ immediate or remote which contraindicate its use. For some time we have tried certain changes in our technique with the idea of preventing the occurrence of the fall in blood pressure and the retching which so frequently follows the anæsthesia. Recently some progress has been made in this direction by injection of adrenalin subcutaneously (for slow absorption) immediately after the injection of the drug into the spinal canal. While it has proved to be of undoubted

value it has not entirely prevented these sequelæ.

As stated above we believe spinal anæsthesia has its place in the realm of anæsthetics but we do not consider it ideal or to be used routinely. In some instances it certainly has approached the ideal but its occasional unexplained total or partial failure denies its being generally speaking a completely satisfactory anæsthetic. However when used properly it is the best anæsthetic available at the present time. We use apomorphine because we know of no drug taking all things into consideration that is better. We use it because we believe in its safety and its comparative efficiency but we use it with the feeling and hope that some day it will be discarded for a better anæsthetic. Adopting a popular advertising slogan—when a better anæsthetic is found we will use it.

## RADIUM IN THE TREATMENT OF UTERINE PATHOLOGY<sup>1</sup>

BY IRVIN ABELL, M.D., F.A.C.S., LOUISVILLE, KENTUCKY

THE indications for the use of radium in the treatment of pathological lesions of the uterus have been since 1920 rather definitely defined, its dangers and the contraindications to its employment have become equally clear. While it has not proved as widely efficacious as at first thought to be, its results in certain conditions have been demonstrated to surpass those of any other treatment heretofore employed. A brief review of the writer's limited personal experience with it in the treatment of carcinoma of the cervix, carcinoma of the body, fibromyomata and uterine hæmorrhage of functional origin is presented as a basis for discussion of some of the problems with which such lesions are associated.

### CARCINOMA OF THE CERVIX

As I became convinced that irradiation in carcinoma of the cervix offered definite advantages over the various surgical measures employed, I have since 1921 considered irradiation the treatment of choice. The considerations and observations leading to this conclusion were the greatly lessened mortality and morbidity entailed by the use of radium as compared with operative measures. The three conditions which obtained in every radical operation for cancer of the cervix—blood loss, trauma and prolonged anæsthesia—are eliminated thereby obviating the reduction in tissue reaction and general vitality which these

factors produce. The ultimate results as related to prolongation of life and apparent cure compare favorably or excel those of operation. All but the most advanced cases can be benefited to some extent by its employment and though they finally succumb to the disease they are frequently spared the suffering induced by the hæmorrhage and infection from the foul sloughing vaginal mass. By far the vast majority of cervical carcinomata is of the epidermoid type which are quite susceptible to destruction by irradiation. Up to and including 1926, 30 patients with carcinoma of the cervix have been treated with radium alone and 1 with implantation of radium in the field of operation after panhysterectomy. In this latter patient, age 49 years, operated on in June, 1922, the uterus and broad ligament lymph nodes which were palpably enlarged were removed, the vaginal vault was left open and two 50 milligram capsules of radium were introduced, one in each broad ligament held in place by gauze packing and removed through the vagina. This was followed by marked pelvic reaction, the entire pelvis became filled with a hard sensitive mass accompanied with much burning pain in bladder and rectum. During the third week some incontinence of urine was noted although the patient passed from 40 to 50 ounces of urine from the bladder daily. Eight weeks after operation and irradiation the mass was smaller and incontinence had all but

disappeared when a large mass of sloughing tissue was extruded from the vagina following which total incontinence obtained. Cystoscopy September fourth 10 weeks after operation showed a large vesicovaginal fistula. Death followed some months later from pelvic abdominal extension.

Of the 30 treated with radium alone were in the third decade ages 22 and 5 years 2 were in the fourth decade ages 32 and 34 years 7 in the fifth 12 in the sixth and 7 in the seventh decades. The dosage given has been on an average of 3 000 milligram hours. The patients treated during 1922 were as a rule given smaller doses and it is interesting to note that 2 of these given respectively 400 and 3 000 milligram hour doses are known to be living and apparently free from recurrence now in their fifth year since treatment while a further group of 3 given respectively 3 000 3 000 and 400 milligram hour doses and now in their third year since treatment are known to be well and apparently free of disease. Of the 31 patients in this group we have been able to trace 22 9 of whom are known to be dead 9 are living and state that they are apparently well and 4 while living are known to present evidence of the continued presence of cancer.

One death occurred as the immediate result of the radium application the patient age 40 years presented an epidermoid carcinoma involving chiefly the anterior lip of the cervix presenting as a large cauliflower mass. This latter made entrance into the cervical canal difficult and in part was removed with the curette to facilitate the introduction of the radium into the canal. Forty-eight hours later she developed a temperature of 103 degrees from which time on she presented the evidences of sepsis complicated by a severe hæmorrhage on the seventh day requiring packing for its control and died on the eleventh day from what in the light of its clinical course was interpreted as septicæmia.

In addition to the vesicovaginal fistula mentioned above one other has been noted. The patient age 50 years came under observation in October 1911 with a vesicovaginal fistula which had followed an hysterectomy in the preceding April which she stated was done for cancer. As no evidence of the latter could be detected the fistula was repaired by the ordinary surgical measure. She was not seen again until 5 years later December 1914 when she presented cancerous induration and ulceration in the vaginal vault. She was given 1 000 milligram hour dose of radium in January 1915 followed later by X-ray. In July 6 months after the radium and immediately after the last of 6 X-ray treatments

incontinence of urine was noted. Examination in October showed both a vesicovaginal and a rectovaginal fistula and while the patient is now still alive she is slowly but surely approaching the inevitable end. The development of fistula in these cases is in harmony with the known observation of their liable occurrence when patients presenting infiltration of vesico and recto vaginal septa are irradiated and emphasize the importance of extreme caution both in dosage and technique of application when such involvement exists. In fact in the utterly hopeless case the possibility of fistula formation would seem to question the propriety of irradiation since such annoying complications but add to the patient's discomfort. In so far as known no patient has developed pyometra but many have complained of persistent mucopurulent discharge which has proved resistant to treatment.

#### CARCINOMA OF THE FUNDUS

The use of radium alone in the treatment of carcinoma of the body of the uterus is believed by the writer to be contra-indicated for the following reasons. Cancer of the fundus is usually of the adenocarcinomatous type which does not readily respond to irradiation its known tendency to metastasize to the ovaries makes it desirable to remove these organs in every case and imperative to remove them if such metastasis has occurred in order to obtain a cure. Finally the results of surgery in permitting the ablation of more cancer-bearing tissue are superior to those of radium.

We have employed radium alone or in combination with panhysterectomy in seventeen patients ranging in age from 31 to 68 years. The limitation of the treatment in 11 patients to radium alone was made necessary either by the presence of general physical conditions which prohibited the employment of a major surgical operation or to demonstrable extension of the disease beyond the uterus. In the latter instances being used as a palliative measure for the control of bleeding. Of the 7 who died death occurring in from 6 months to 3 years after irradiation 2 are living and well and 6 years respectively after treatment while 4 are living with demonstrable disease present and 6 years after initial treatment. Since the physical condition of this group precluded operation radium has afforded a prolongation of life in comparative comfort for 2 as long as 6 years while in 2 no further evidence of the disease can be detected. The duration of these 11 cases varied from 100 to 3 000 milligram hours. In the 6 instances in which radium was employed in conjunction with panhysterectomy

its use as a pre operative measure was not an intentional one. It has been our practice to do a diagnostic curettage on every patient presenting uterine pathology on whom the use of radium is contemplated. In 6 patients presenting uterine hemorrhage as a major symptom a curettage was done and radium applied. Subsequent examination of the removed tissue revealing adenocarcinoma panhysterectomies were done within the week. In so far as known 5 of these done from 1 to 3 years ago are well while the sixth showed a recurrence at the end of 10 months. The location of this recurrence was of interest in that it was situated in the anterior vaginal wall below and to the left of the outer terminal portion of the urethra. Further irradiation but temporarily inhibited its spread.

#### FIBROMYOMATA OF THE UTERUS

The indications for the treatment of fibromyomatous growths involving the body of the uterus are variously interpreted by surgeon and radiologist. The logical analysis of the situation appears to me to be as follows: in women under 40 presenting such growths the treatment of choice is surgical removal employing transfusion and irradiation in moderate dosage for the purpose of making operable those patients in whom continued bleeding and profound secondary anemia temporarily prohibit operation. The reasons for this conclusion are—first ocular inspection will in some cases permit of myomectomy with the preservation of the child bearing function second preservation of the ovaries independent of the retention or ablation of the uterine body is of importance. The younger the patient the greater the importance of the preservation of the ovaries because of their internal secretion and the part they play in the establishment and maintenance of the sex function particularly in the earlier years of life. Again many women have an abhorrence of the induced menopause regardless of how produced whether by surgical removal of the ovaries or their destruction by radiation. Irradiation of fibromyomata in such women may engender an inferiority or abnormality complex rendering them unhappy for the remainder of their days and surely mental tranquility transcends in importance the per cent risk which operation entails. It is readily admitted that there is an opposite picture to this namely those who desire and prefer irradiation even though it involves destruction of the ovaries rather than operation with its concomitant pain discomfort confinement and convalescence. At and after the age of 40 years the child bearing function of the

uterus has usually been fulfilled the distortion of the organ incident to the growth may be such as to prevent conception or to interfere with pregnancy granting its occurrence and the proximity of the approaching menopause makes negligible the importance of ovarian preservation. Hence irradiation at this age finds a comparatively wide field of usefulness its limitations being determined by the size of the tumors and their situation by pedunculation by tumor degeneration and by adnexal disease. We have employed radium alone in the treatment of 15 patients with fibromyomatous uterine growths but were under 40 (17 and 39 respectively) 8 were between 40 and 50 and 5 between 50 and 55 years of age. In 12 patients the tumor was at or below the size of a 3 month pregnancy in 2 the size of 1 4 month pregnancy and in 1 that of a 6 month pregnancy. The dosage of the radium has varied with the size of the tumor from 100 to 3000 milligram hours. Bleeding has been controlled in every patient and there has been an appreciable reduction in size or disappearance of the tumor in all but 3. In the first of these a diabetic age 54 years with a tumor the size of a 3 month pregnancy 1300 milligram hour dose of radium was given September 193. In January 1924 while bleeding had ceased an annoying vaginal discharge was present and at times discomfort was noted in the tumor which had not decreased in size. Supplementary X ray treatments were made to tumor in January and February. The last examination April 17 1924 showed but slight reduction in size of the growth. The second age 50 years presented a multinodular tumor the size of a 10 week pregnancy. In May 1925 a 1500 milligram hour dose of radium was applied. By September 1924 the tumor had increased in size until it filled the pelvis and extended into the right half of the abdomen as high as the umbilicus. At operation it was found that the tumor mass originating in the body of the uterus had remained stationary in size or possibly was slightly smaller than at the time of application of radium while the massive increase in size had occurred in two subperitoneal nodules one of which showed calcareous deposit. In the third patient age 45 years presenting a multinodular growth of the size of a 4 month pregnancy surgical removal was advised and declined with insistence upon the use of radium. A 2400 milligram hour dose was given. Pain in the tumor was noted on the fifth day accompanied by a temperature varying from 99 to 101 degrees until the ninth day when a severe rigor was followed by a temperature of 104 degrees and

a problem that before the advent of radium required hysterectomy for its solution. Radium as a rule requires but one application and the dosage can be measured fairly accurately according to whether one wishes to diminish the uterine bleeding or to produce complete cessation of menses. The induction of the menopause by radium implies the loss by the ovary of its internal secretion and of its follicular activity; consequently in cases of intractable bleeding not controlled by moderate doses it would seem wise to induce the menopause with radium only in those patients approaching middle age, reserving the surgical removal of the uterine body for younger women since it permits of the preservation of unimpaired ovaries. The dosage in this series has varied from 150 to 2400 milligram hours depending on the desired result to be achieved. But 3 of the 70 patients returned on account of recurrence of bleeding. One of these an unmarried patient age 30 years was under observation 2 years during which time she was curetted twice, had 2 applications of radium of 600 milligram hours each, 2 transfusions of whole blood, administrations of horse serum, glandular extracts, iron, arsenic, calcium salts and various styptics including ergot, hydrastis and stypticin with but temporary control of bleeding. Following a preference for removal of the uterus in young women rather than induction of the menopause with radium, a supracervical hysterectomy

with removal of a cystic right ovary was done. Microscopical examination of the specimen showed chronic endocervicitis, chronic endometritis and simple cysts of ovary. But one patient age 30 years showed any marked reaction doubtless due to a parametrial inflammation present at time of application of radium, the ultimate result being satisfactory. One patient has noted marked vaginal spasm and dyspareunia since irradiation and another has complained of annoying pruritis. While a certain amount of vaginal discharge is almost routinely noted following radium treatment such flow is usually of short duration and responds readily to soothing douches. In a small number of patients an intractable irritating vaginal discharge has persisted for months. Recent communications have been received from 5 patients of this group, 36 of these ranging in age from 38 to 50 years to whom a dosage of from 1000 to 2400 milligram hours was given report complete cessation of menses of 16 ranging in age from 16 to 36 years to whom doses ranging from 150 to 800 milligram hours were given, 13 report menstruation as normal in quantity, 1 as normal for 2 years at which time radium was again used in another clinic, 1 as normal for 1 year when a curettement was done elsewhere for recurrence of bleeding, and 1 reports the bleeding as markedly lessened but still greater than her normal.







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## EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

FRANKLIN M. T. M.D. M. 11 to  
ALLEN B. K. M.D. A. 11 to

WILSON JIMMY M D CLIFF LUTHER S JR

JULY 19 8

THEORETIC COMPASS MEDIA  
POLYMEROGRAPHY

**T**HE use of the roentgen ray in diagnosis is based solely on the relative translucency to it of the tissues and organs of the body though invaluable would be decidedly limited by application. It is an invaluable no marked or extensive change in normal tissue densities such as ulcer, stricture, dilatations, soft tumors and abnormalities in the relative position of organs would be for the most part unrecognizable. The principle of contrast media delineation removed this limitation in proportion as suitable media and proper technique for their introduction were developed. Such delineation of gastro intestinal and urinary tract lesions marks one of the greatest achievements in modern diagnosis. The Graham Cole method of utilizing the gall bladder involved the finding of a substance opaque to the roentgen ray for selective liver secretion.

The limitations of unaided thoracic roentgenography are less marked because the air in the lungs acts as a normal contrast media bringing structures into sharp relief and accen-

turting the shadows of inflammatory or neoplastic increase in density.

There have been nevertheless very real and serious limitations to the roentgen ray diagnosis of the chronic disease. A uniformly thickened pleura or a pleural effusion cloud the contrast media effect of the air in the lung and effectively mask any coexisting pulmonary lesion. Intrapulmonary shadows that are revealed may also be of uncertain or indeterminate significance. The heart and dome of the diaphragm overshadow markings of lung pathology. Air containing dilatations or cysts or fracture of bronchi may produce no definite findings. The exact status of fistulous tract in lung and pleural cavities is not demonstrable with the use of suitable contrast media.

The great value of the mueth paste in the study of mueth and cystitis was brought out by Beck but this media if introduced under pressure into the empyema sinus may produce symptoms of serious cerebral manifestations in time sufficiently fatal. It is also unsuited for intratracheal injection of the bronchi. Solutions of sodium iodide or other salts serve well to outline empyema cavities but are too irritating to be injected into the bronchial tract.

The possibility of visualizing the bronchial tree roentgenographically was suggested by the accidental penetration of small amounts of bismuth paste into the trachea through tracheal esophageal fistula. In 1918 Chevalier Jackson succeeded in outlining the right bronchus by insufflating into it bismuth powder through the bronchoscope. Two years later Lynch reported cases of pulmonary abscess similarly visualized. The necessity for bronchoscopic introduction of the powder and

its limited distribution however would probably have greatly limited the applicability of this method even if more suitable media had not been developed. The preparation of 40 per cent metallic iodine in poppy seed oil introduced by Sicard and Forestier in 1911 making roentgen ray bronchography relatively safe and practical promises to be as notable an achievement in the diagnosis of thoracic disease as the bismuth meal or enema has proved in that of the gastro intestinal tract. The iodopin of the Germans and "iodumbrin" of the Danes are similar preparations.

The greatest field of usefulness of these contrast media is in the differential diagnosis of bronchiectasis which next to tuberculosis is the most common chronic pulmonary disease.

The physical sign of bronchiectasis are often limited to a few rales and the roentgen ray findings to linear shadows of uncertain significance. In combination with chronic cough and an abundance of purulent sputum showing no tubercle bacilli these findings should serve to establish the diagnosis but the type and distribution of the bronchiectatic dilatations remains indeterminate. It is often impossible to differentiate between unilateral and bilateral involvement except perhaps bronchoscopically. The disease has often masqueraded for years as chronic bronchitis, tuberculosis, abscess or recurrent 'colds'. Early diagnosis has been the exception. It has probably never been diagnosed with certainty in its incipency. The dry type of bronchiectatic dilatations producing no cough or sputum presumably of congenital origin probably has never been recognized except at necropsy. In the iodized oil contrast media we have a means of visualizing the dilatations in the earliest stages of the disease when most amenable to treatment and of determining objectively the best type of treatment. Bronchiectasis coexisting with thickened pleura, empyema, tuberculosis or

subphrenic abscess can be recognized with certainty only by such contrast media visualization.

Pulmonary abscess with wide open communications with a large bronchus may be directly visualized with iodized oil if empty or after having been emptied bronchoscopically but the oil may entirely fail to gravitate into those with imperfect drainage notably those situated peripherally. In many such cases the injection of the bronchi leading to the diseased area of the lung furnished indirect evidence of the presence of an abscess in that the lipiodol fails to penetrate into the terminal bronchi in the surrounding consolidated lung tissue. This abrupt ending of the bronchial shadows also serves to differentiate between lung consolidation and localized pleurisy with or without effusion. After thoracotomy drainage the lipiodol may give an excellent delineation of a multilocular abscess cavity and of its fistulous ramification.

In empyema the method is of great value in establishing the presence and ramifications of bronchial or intrapleural fistulous tracts or multiple communicating cavities.

Bronchogenic tumors of the lung the incidence of which seems to be on the increase as a rule are recognized late if at all clinically. The dilatations or blockage of the bronchi as shown by the injected oil whether with or without symptoms of infection suggest the possibility of a neoplasm as the underlying lesion.

In pulmonary tuberculosis the method serves to outline cavities and secondary bronchiectasis but crises have been reported seeming to show that the iodine gradually set free may stimulate the tuberculous process to renewed activity. The value of the visualization is also minimized from the standpoint of treatment as indications for compression therapy must usually be determined on other grounds.

The application of the principle of contrast media roentgenography to the study of the diseases of the thorax made possible by the development of iodized oil thus seems of the greatest importance to their earlier and more accurate diagnosis and more rational and effective treatment. CARL A. HEDBLOM

### THE SPLEEN

THE spleen cannot be regarded as an organ apart but only in relation to various systems—lymphatic, circulatory, portal and reticulo endothelial. It is affected reflexly by various forms of stimulation and in turn has a direct effect on the blood.

Removal of the spleen in man preceded its removal in the experimental animal and much of our knowledge concerning the spleen has been derived empirically as a result of extirpation of the spleen. It is interesting to note that many of the views of the ancients have been corroborated. Anatomical and pathological studies have failed to throw much light on the function of the spleen but recent physiological and chemical research has revealed interesting facts which seem to indicate that our fundamental knowledge will be obtained by experimental work.

Although the spleen contains a large amount of lymphoid tissue the activities of this tissue are not clearly understood and it is only in pathological lymphocytic hyperplasia of the spleen that the lymphoid characteristics assume prominence. It has been clearly shown that the normal spleen exerts a biline on the circulation both with respect to blood volume and the number of erythrocytes especially during exercise and hemorrhage. The direct effect of removal of the spleen on the amount of blood passing through the liver has been demonstrated. The enlarged spleen in certain pathological states contains enormous quantities of blood and in these cases the degree of

relief of the load on the diseased liver assumes definite proportions. The effect of the spleen on the blood is demonstrated by the recovery of the normal platelet count in cases of hemorrhagic purpura following splenectomy. The recovery is so rapid that a direct effect must be postulated and it is probable that in this disease the spleen destroys platelets, possibly chiefly the older forms of platelets. The reaction of the spleen in chronic infectious processes seems to have little to do with the reticulo endothelial structure. It affects chiefly the circulatory system and fibrous tissue producing chronic fibrosis and often infarct.

The idea is general among the laity that persons from whom the spleen has been removed do not live long. This misunderstanding is doubtless due to the fact that in many instances the spleen has been removed not with the expectation of cure but with the idea of prolonging life. It seems important therefore that the public should be informed that cure can be expected only in certain diseases of which the outstanding examples are hemolytic icterus, purpura hemorrhagica, splenic anemia and splenitic splenomegaly. Results obtained from splenectomy in cases showing the syndrome of splenic anemia are unsatisfactory partly because splenectomy has been performed in cases in which on careful study the condition seems to be the result of a chronic recurring infectious process.

The most interesting problems at present from the experimental standpoint are those in connection with the spleen as a part of the reticulo endothelial system and from the clinical standpoint are those concerned with the determination of the advisability of splenectomy in the individual case. This latter satisfactory diagnosis has been reached seems to be chiefly decided by satisfactory function of the liver and absence of evidence of chronic recurring infection. H. Z. GRIFFIN





D HAYES AGNEW  
1818-189

# MASTER SURGEONS OF AMERICA

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D HAYES AGNEW

ON mid days of the late seventies and early eighties for instance 1883 in an ill lighted worse ventilated superheated lecture room of the typical funnel shape not yet extinct on straight backed benches of incredible hardness and discomfort some two hundred and fifty smoking singing whistling bantering tussling students waited the coming of the John Rhea Barton professor of the principles and practice of surgery in the Medical School of the University of Pennsylvania

On the minute of twelve through the swinging door of the pit entrance came D Hayes Agnew Tall lean lithic florid white hair somewhat long as was his drooping moustache bushy eyebrows over clear keen blue eyes slender shapely hands of great strength Wearing a high stock a frock coat dark trousers changed to light in the spring and highly polished boots accentuating small narrow feet

With Agnew's entrance the tumult of waiting exuberant youth gave way to a brief burst of applause something more cordial than the perfunctory hand clapping with which all other professors were then greeted

The brief rustle of opening note books was followed by a moment of attentive silence broken by Agnew's agreeable well modulated voice setting forth with singular clarity and directness the groundwork upon which the practice of surgery should be built

At the hour's end as Agnew left the room again there was applause vigorous and astonishingly prolonged since it was the students' lunch hour Thereafter the crackling of matches the trampling of many feet the joyous careless hurry of healthy youth keen for that boarding house fare which while condemned as uneatable was consumed in such quantity as to render the entire class somnolently unresponsive to the first afternoon lecture

Agnew lectured to crowded classes though no effort was made to keep a record of attendance He based his surgical teaching on anatomy symptomatology a sharp knife and a hand trained in its use His talks were forceful enduring in their effect His demonstrations were astonishing in their smooth swiftness and surety of result



Agnew was of Scotch Irish descent and inherited his height since his great grandfather Pobert the shortest of seven brothers measured 6 feet 2 inches His grandfather David one of nine children became the father of twelve and died leaving a widow who married a widower whose children numbered seven

His father Pobert Agnew a graduate of Dickinson College a surgeon of note and an elder in the Presbyterian church married a handsome widow the mother of two children who bore to him David Hayes Agnew The latter received his literary education at Jefferson College Canonsburg Pennsylvania the stronghold of Presbyterianism subsequently becoming part of Washington and Jefferson College at Washington Pennsylvania and writes of this institution he then being eighteen years old that the refectory was infamous the food was poor and badly served a criticism which has always been voiced of all educational institutions by each generation of students

After graduation from the Medical Department of the University of Pennsylvania Agnew practiced at Nobleville and Christiana for three years He records at this time that it was hard riding hard reading hard working small fees He played the violin followed the hound owned and rode a famous horse of the

Tom breed was a lover and trainer of dogs and was known throughout the countryside as a devil hunter and a judge of horses

Marrying into a family interested in the iron business he was persuaded to abandon for a time the practice of medicine in favor of a business career His firm later assigned and it is worthy of note that Agnew ultimately paid every penny of the loss sustained by those who invested therein

Thereafter he returned to the practice of medicine and settled in Cochranville Chester County Pennsylvania but remained as in student days vividly interested in anatomy securing bodies for the purpose of dissection and study from Philadelphia and placing the bones in a pond to be cleaned by the eels which were much esteemed as food by the community Agnew's method of fattening them was not approved nor for that matter was the use of the human body for scientific purposes Falling into disfavor in his community he determined to settle in Philadelphia but at the request of Dr Sample took charge of the neglected practice of the latter's son at Soudersburg ten miles from Lancaster Speaking of his experience there many years later Agnew said I located at Soudersburg when a young man I stayed there long enough to know all the roads in the district but I found the people there wanted a better doctor than I was likely to prove so I moved

It was perhaps at this time that he found some comfort in Voltaire's definition of a physician An unfortunate gentleman who is expected to perform a miracle every day in reconciling health with intemperance

Coming to Philadelphia and finding at last his true bent he threw all his energy into his school of anatomy of which he took charge in 185 At this time

the use of the human body for dissection was not regarded with such favor by the laity nor with such large tolerance by legislators as to make the securing of adequate material other than difficult and dangerous. Agnew's supply was always adequate. During the cholera epidemic he might have been but forunately was not found in those trenches where the almshouse bodies were dumped injecting by day and resurrecting by night.

During the more than ten years of his control of the anatomical school he delivered over 1800 lectures teaching and demonstrating both summer and winter. An associate Dr. Garretson speaks of him as having an uniquely un speculative mind on the subject of religion. When questioned as to body, ego and soul Agnew briefly replied that he was sure of the body was willing to leave the ego to philosophy, the soul to the church.

Agnew's growth to the master position was slow, even slower was the recognition by the schoolmen that he had attained this growth. Appointed by Leidy demonstrator of anatomy in the University of Pennsylvania, he remained in this minor position seven years when because of his increasing practice tendering his resignation he was made professor of clinical and demonstrative surgery, this when he was 57 years old and had been practicing medicine thirty one years. A year later he was made professor of surgery, retaining this position for eighteen years.

By the early eighties Agnew was recognized by both the medical profession and the laity as the master surgeon of America by the medical profession because of his headship and conduct of the Philadelphia School of Anatomy which meagerly equipped and with but nine students he bought in 1852 for six hundred dollars and sold for the same sum in 1863 with full equipment and 267 students the world's largest private class under an individual teacher, also his leading rank was accorded him by the profession because of his large army and hospital experience, his textbook on surgery and his papers on applied anatomy which were recognized and accepted as standard of authority.

Hence when President Garfield was shot in 1881 his attending surgeon looked on Agnew as the obvious consultant. His connection with this case and his bearing throughout stamped him to the layman as a leader.

As Garfield about to take a train was passing through the Baltimore and Potomac Railroad Station he was shot, the bullet entering four inches to the right of the midline of the back at the level of the eleventh rib. Garfield fell and when carried to the second story of the station was pale, cold, wet, thirsty, vomiting, with a running pulse and suffering severe pain and marked hyperaesthesia of the legs, particularly marked on the right side. The surgeon promptly probed downward to the depth of  $3\frac{1}{2}$  inches and followed his metal instrument by his little finger introduced to its full length.

The reaction from shock was slow but complete. The next day the surgeon general made a further digital exploration of the wound tract and of the

consultants called on the third day it is stated they did not attempt to force their probing with too much vigor. There is no record to the effect that Nelaton turned in his grave nor that Lister groaned aloud though there was at the time a protest regarded by both the profession and the laity as inspired by envy and voiced by the votaries of the false god antiseptis whose credo failed to recognize wound suppuration as inevitable and whose cult enforced a time consuming ritual with results no better if as good as those incident to methods sanctioned by the centuries. Agnew called on the third day decided against operation and thereafter was concerned with insuring drainage for an abscess burrowing into the iliac fossa and for other septic manifestations among them sloughing pyotoids.

When death occurred some two and a half months later the bullet was found harmlessly encysted remote from the suppurating area which centered around an osteomyelitis at the seat of the shattered vertebral body.

Agnew was brought up strictly in the tenets of Presbyterianism attended church regularly refusing all posts of honor therein. He saw on Sunday only those patients whose needs were urgent was quietly deeply and consistently religious.

As a teacher he had that rare gift of clarity accentuating and illumining the high points avoiding unessential and confusing details. He believed and taught that surgery should be based on a brain eye and hand knowledge of anatomy a sharp knife fingers trained in its use practiced diagnostic ability and an understanding heart tender toward the afflicted and with the single purpose of bringing help to both body and mind.

This being before the efflorescence of specialists subjects now relegated to them were grouped in the surgical course among them affections of the skin which Agnew briefly covered by the statement that they might be classified under two headings namely those which are cured by the application of zinc oxide ointment and those which are not thus cured.

He believed that woman's place was in the home that her education should be confined to reading writing arithmetic belles lettres and housekeeping and was so opposed to her as a medical student that he resigned from the Pennsylvania Hospital staff rather than have one or more attend his clinics.

He was among the first in this country to practice the ritual of Listerism this at an age when upon many minds a new idea has the effect of a foreign body upon the grosser tissues and is either encapsulated and disappears or sets up an irritation and is extruded. (J. William White)

He was ambidextrous deft and swift in his manipulations without seeming so to be. Student crowded his clinics in particular those devoted to cutting for bladder stone. When a patient was assuredly diagnosed by means of a resonator attached to a steel sound and was duly prepared with a grooved staff passed into the bladder Agnew would make one ample perineal cut into the posterior urethra drop

his sharp pointed knife take from his teeth his blunt pointed one make with it one further ample cut through a lateral lobe of the prostate insert his forceps and remove the stone in less than six seconds and with a deceptive appearance of deliberation

Agnew was a scrupulous observer of professional etiquette both in action and in spirit Operating upon a patient suffering from a long continued suppuration following an operation by a brother practitioner Agnew made one deep free incision seeming to his resident perilously near the femoral artery passed in two fingers so neatly palmed a lingering sponge which had been the cause of the trouble that it was seen only by his assistant and made no remark other than this free drainage should cure your patient Doctor

Agnew died of angina pectoris aggravated by influenza To his students and colleagues he was Master not only because of his textbooks his honors his manual dexterity and surgical skill his diagnostic acumen his clarity of thought and expression but because of a personality which in either group or individual contact left an impression of singleness of purpose of joy in service of sympathy with weakness of an understanding heart A personality actively and beneficently contagious

In the University of Pennsylvania there is an Agnew wing endowed by the Master In the Library of the College of Physicians there is an admirable Biography of D Hayes Agnew written by his nephew Dr Howe Adams and from which much that has been written in this sketch has been taken

Even the most powerful in his day and generation is promptly forgotten unless he leave a named legacy The Agnew wing should be the Master's benediction for many generations of teachers students and patients EDWARD MARTIN

D Hayes Agnew was born in 1818 died in 1890 He received an M D degree at University of Pennsylvania in 1838 He was owner and conductor of Philadelphia School of Anatomy 1852-63 He was acting assistant surgeon U S Army and consultant to group hospitals Demonstrator of Anatomy University of Pennsylvania 1863-70 Professor of clinical and demonstrative surgery University of Pennsylvania 1870 John Rhea Barton professor of surgery 1871-89 Emeritus professor of surgery 1889-9 Surgeon to Philadelphia Hospital Pennsylvania Hospital Wills Eye Hospital Orthopedic Hospital He was author of *Principles and Practice of Surgery* 3 vols 1878-81-83 *Regional Anatomy in Its Relation to Medicine and Surgery* *Researches on Organization of Blood Clot and on Repair of Fracture* and many contributions to textbooks encyclopedias and current medical literature He was president of the College of Physicians president of The American Surgical Society founder and president of the Academy of Surgery member of The American Philosophical Society and member of the Board of Directors of the Union Trust Company

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

By ALFRED BROWN M.D. F.A.C.S. OMAHA

### CONCEIVING DISEASES OF WOMEN— HIERONYMUS MERCURIALIS

IN the sixteenth century obstetrics and gynecology as well as surgery came in for a certain share of attention. Based upon the work of Soranus of Ephesus followed by that of Trotula at Salerno Eucharius Rosslin of Wurms published his *Rosengarten* in 1513 in which he taught the podiatric profession first suggested by Soranus. By this he furnished the inspiration to a few men for more careful consideration and study of this phase of medicine. In England the *Pragmatica* was translated from the Latin into English by one Richard Jonas and appeared in 1540 under the title *De Partu Hominis*. Subsequently practically the same book appeared under the title of *By the of Mankind* with the name of an Englishman Thomas Rastold. By this as author and as the author of an obstetrical portion in English for a century.

By the early work Germany a Hildesheim were supplied with manuals on obstetrics which served for teaching purposes. Sylvesterius soon supplied the high instrumental view of Jacob Rueff who published his *Eischoenlustgrotte* in 1554 in which he alluded to the purely obstetrical portion thereof as a chapter monster. In France the lecture of obstetrics was taken up by Iar and all things attempted he published sized the method and deduced one. He indicated podiatric version and the first to introduce labor at term to check hemorrhage. A lesser known physician of Paris Niccolus Rucheus also wrote a book on obstetrics. As far as to be expected Italy kept pace with the advances made in other parts of Europe in this department of medicine. Very little appeal in the notes of the great University of Padua and Jacobus Sylvius and Vito Iarullo taught obstetrics and disease of women. Lulycus Boerhaave a professor in Ferrara also taught a deal on the subject.

The largest book on obstetrics and gynecology by an Italian during the sixteenth century as the one based upon the lectures given by Hieronymus Mercurialis presumably when he filled the Tincavelli's professor at Padua upon the latter's death in 1568. Mercurialis wrote and lectured on nearly all the recognized departments of medicine and among other considered the subjects of obstetrics and gynecology. The book is not written by him but like

many of the volumes attributed to him was apparently a transcription of his lectures by one of his students subsequently corrected by him. The *Lectures on Disease of Women* was first published at Basel in 1582. Later it appeared as part of a general work on gynecology published in 1586 and the volume here illustrated appeared in Venice in 1587 printed by Valgrisius. It was also published in Strassburg in 1597.

This volume was the combined work of two of Mercurialis' pupils for the title page reads *Lectures on the Diseases of Women* from the lips of Hieronymus Mercurialis recently edited by Caspar Balthasar author until lately little known. Now truly enlarged and amended with the consent of the author by Michele Colombo from the collation of many examples. With an exhaustive index of chapters and contents 1587 at Venice at the house of Iulius Valgrisius. The book is thus an example of a procedure common during the sixteenth century when each professor in a large school had his Boswell usually the person of one of his students or assistant. The amanuensis took notes on the lectures and wrote them up. They were then corrected by the professor and published. In this way the idea of a printed text of these men too much taken up with other matters to do their own writing have been handed down to us. A list of authors cited in an early German edition of 1586 contains one hundred and one names and contains an idea that the even years study by Mercurialis in Rome had given him a great knowledge of the literature of the ancient. As for the case however the names of recent authors for contemporaries are lacking and though Soranus Trotula and others are mentioned the name of Rodolphus Jakobus Rayalde Rueff Pare and others are lacking. It would seem nevertheless that Mercurialis was at least conversant with the work for in the second book which deals with labor he describes podiatric version which was at the time being popularized by Par in France.

The first three books deal with obstetrics treating in succession conception pregnancy labor and the puerperium. The fourth book deals with diseases of the genitalia regularities of menstruation gonorrhea the white menses (leucorrhoea) pruritus and other conditions both physical and psychic. A definite form of description is used throughout consisting of a description of the disease the causes the symptoms the prognosis and the treatment.

# DE MORBIS MVLIEBRIBVS

Prælectiones ex ore

HIERONYMI MERCVRIALIS

Iam dudum a Gaspare Bauhino exceptæ,  
ac paulo antea inscio autore editæ

NVNC VERO PER

MICHAELEM COLVMBVM

*Ex collatione plurium exemplarium consensu auctoris  
locupletiores & emendatiores factæ*

CVM INDICE CAPITVM ET RERVM LOCVPLETISSIMO



M D LXXXVII

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Venetis, Apud Felicem Valgrisium



## REVIEWS OF NEW BOOKS

THE ninth edition of Cabot's *Physical Diagnosis*<sup>1</sup> has been carefully revised. Analyses of further statistics have been added so that this work becomes not only a didactic pre-entation of physical signs but one on general differential diagnosis. In the chapter on heart murmurs the corresponding numbers of phonographic record are attached to the diagrams. This should be of great value for teaching and for ear training. In opening the discussion on auscultation the author describes the multiple Bowles stethoscope. This suggests the multiple electrical stethoscope which by amplification and transmission of heart sound enable an auditorium full of students to listen simultaneously with their teacher. This is a device which Doctor Cabot has used with great success in teaching.

The volume continues to be the best short work in its field. It is full of characteristic refreshing denials such as "I can recognize no tricuspid murmurs and I never heard this sound." Conclusions are arrived at with originality and disregard for opinion since they are based upon first hand analysis of his own statistics. Most interesting deductions are made. Some of these are old and have long been supported by experience such as the remark that urine tests for indican, urea sulphates and phosphate give the appearance of accuracy and scientific method in diagnosis but not the reality. Other statements such as "I have never seen any evidence that excessive muscular work is by itself capable of causing cardiac hypertrophy and dilatation" tend to be supported by the most recent physiological work.

Thus for extent of material presented and for stimulating observation this volume continues to be one worth repeated study. PAUL STARR

IN this interesting volume containing thirty even of the Practical Lectures delivered before the Kings County Medical Society men of prominence in the various specialties have been selected to present subjects most likely to be of value to the doctor in general practice.

Several of the lectures have particular interest. George W. Crile's "The Surgical Treatment of the Thyroid Gland" is based on his experience in performing 13,088 operations upon the thyroid gland. The United States Public Health Service is explained by Surgeon General Hugh S. Cumming.

"The Doctor in Court" is full of interest and instruction for those unfortunate enough to have to go there.

Steven Emer on gives his reasons for advocating periodical health examinations. John H. Gibbon

in his "Common Sense in the Treatment of Fractures" very properly includes commendation of the many methods of Lucas Championniere.

Inherited Syphilis is well covered. Foster Kennedy contributes a lecture on Fits. Frank H. Lahey discusses the Varieties and Treatment of Goiter. George M. MacKee devotes 64 pages to the More Common Diseases of the Skin. John O. Polak lectures on Toxæmias of Pregnancy.

The subject are handled in a somewhat elementary manner but the eminence of most of the contributors assure an interesting presentation.

FREDERICK CHRISTOPHER

WOLBARST has compiled a most valuable treatise on *Conoccal Infection in the Male*.<sup>2</sup> He states that the book is designed primarily to guide general practitioners in the proper recognition and management of the disease and its troublesome complications. Specialists and medical students might advantageously familiarize themselves with this text. The author has kept his subject matter completely up to date and his method of presentation is concise and easy to follow. Diagnosis and treatment have been classified according to the pathological involvement of the various anatomical structure.

A discussion on the proof of cure constitutes an interesting chapter. A final chapter by McDonald of London in which he expresses his view on gonorrhea accentuates the divergence of opinion in the two countries. VINCENT J. O'CONNOR

THE author of this book presents a very fine work in German on the subject of X-ray diagnosis in surgery. He states that the material for the book was obtained in the University of Göttingen X-ray Department with the aid of the Pathological Department as well as the medical and surgical clinics of that institution.

The book is a splendid pre-entation of the subject well written and exceedingly well illustrated. It is an example of careful work in preparation of a difficult subject. The book may be recommended to any physician interested in X-ray particularly those who can read the German text. The many illustrations with which the book abounds are of such superior quality and demonstrate pathological changes so well that very little reading matter is required to explain the X-ray features. The volume is large and the subject is treated at length in a thorough manner. EDWARD S. BLAINE

PHYSICAL DIAGNOSIS By R. H. Cabot, M.D. 9th ed. d  
nd N. W. L. Williams, M.D. 9th ed. 97  
PRACTICAL LECTURES ON THE CLINICAL MEDICAL  
SCIENCE By R. H. Cabot, M.D. 9th ed. 97  
The United States Public Health Service is explained by Surgeon General Hugh S. Cumming.  
The Doctor in Court is full of interest and instruction for those unfortunate enough to have to go there.  
Steven Emer on gives his reasons for advocating periodical health examinations. John H. Gibbon

CONOCAL INFECTION IN THE MALE By A. L. Wolbarst, M.D.  
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AS Sir Arthur Keith end his fore orl *Health*  
*Growth* is a most inte e ting book for all who  
are concerned w th lucation—medical sicer  
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of the nation at heart It c nsist of e eral chapters  
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sideration of overwork over pressure and the ail g  
school child a d a co lton b t een the mental  
a d physical acti vity of growing boys It ha five  
appendice devoted to stat st c l method It i an  
authoritative fundamental ork in the most im  
po tant field I S

**P**RESENT clinical knowledge is summarized by Coope, Hobbs and the dagger of pancreatodisease. The book consists of two main parts—the first a brief but helpful treatment of anatomy, physiology and clinical picture, the second a host of ailments which are discussed on a functional level under the heading of attempts to detect flow of digestive fluids into the Duodenum. Intubation as a means of obtaining pancreatic secretions is described with a simple method for detecting lipase. A careful discussion of tests for fermenting the stool gives the conclusion of which is that true creatorexia on a controlled diet is the test for pancreatic deficiency. However, but stools are rare and less amount of fat in the stool may be due to other causes. The whole question

carefully examined. The importance of stool examinations on controlled diet and the use of a laxative in the feces to control the time of transit through the gut are emphasized. The work not only reveals the use of size but because of host analysis. It is to be highly recommended as an eating method of attack in a difficult and little known field.

L. A. SPARR

THE new edition of this important *Treatise on Orthopaedic Surgery* brings it fully up to date and maintains its position as the best modern text book in this field. The subject matter is well and fully presented and includes all information essential to the practitioner or special worker. The descriptions of the most valuable original contributions of the distinguished author, namely the blood circulation of the femoral neck, the open reconstruction operation upon the hip-joint, the tag-lectomy, the backward displacement of the foot, might well receive more space and better illustration. The second sentence of the first chapter describing Pott's disease is unsatisfactory and should be rewritten.

The condition called otoschondritis does not seem to have been a stumbling block to the composer. In the sixth edition of Whitman's book it appears that Decca and in the present edition it appears that Decca.

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In many of the cases the proof reads: has not been done, a matter common to all with the importance of the textbook which fact however does not let a trace of the intrinsic value of the work.

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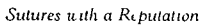
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# SURGERY, GYNECOLOGY AND OBSTETRICS

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VOLUME XLVI

MARCH 1928

NUMBER 3

## CANCER OF THE LARYNX

SYMPTOMATOLOGY DIAGNOSIS AND TREATMENT<sup>1</sup>

By GABRIEL TUCKER MD PHILADELPHIA

Assoc P f f B h py t Esoph g sc py G d t S h l f Med U e ty f P yl A soc t B ch sc ps  
d Es ph g py J f M d l Coll g

It would seem a platitude to say that the early recognition of cancer in any part of the body is of the greatest importance in its cure. The repetition of this statement is justified however when we consider that in intrinsic cancer of the larynx early diagnosis offers a lasting cure of from 70 to 80 per cent. This is a much higher percentage of cure than can be obtained in cancer in any other location in the body. It has been shown by Cuneo that the richly developed lymphatics of the larynx form a network of their own which empties into small glands on either side and does not anastomose with the neighboring lymphatics. The slow metastasis with early diagnosis makes possible the high rate of cure in intrinsic cancer of the larynx. It is therefore imperative that every physician and especially every otolaryngologist recognize the symptoms appearances and means available for the accurate diagnosis of incipient cancer of the larynx.

The classical symptoms as formerly taught—aphonia dysphagia pain in the ear salivation dyspnoea hæmorrhage fetor glandular involvement emaciation and cachexia—occur as evidence of far advanced disease but little attention has been paid to the earliest symptoms of involvement those for which the physician should be on the alert. The first symptoms are persistent local discomfort persistent hoarseness or the two combined according to

the location of the lesion in the larynx. Persistent hoarseness and discomfort in the region of the larynx occurring in an adult of any age should have the skilled attention of the otolaryngologist.

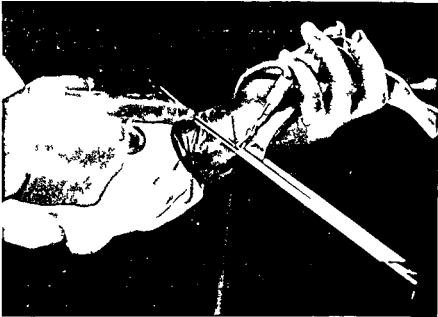
### AGE

Cancer of the larynx occurs rarely under the age of 40 years but there have been cases reported of intrinsic cancer at 16 and 18 years of age and of extrinsic cancer of the larynx at 23 and 24 years of age (10). Only yesterday in our clinic at the University Hospital the histological examination of a specimen removed from an extensive intrinsic ulceration of the larynx in a man 37 years of age was reported as epithelioma by Dr Herbert Fox. The patient had been hoarse for 9 months and during the past 9 months had only a whispered voice. In 100 selected cases from the services of Dr Chevalier Jackson and Dr Fielding O Lewis in which hoarseness was a symptom Dr Austin T. Smith found that the average time from the beginning of hoarseness until a diagnosis was made was 11½ months. Many of these cases were far advanced. Many had been treated under a diagnosis of chronic laryngitis without even an attempted mirror examination of the larynx.

### CLASSIFICATION

Cancer of the larynx was classified clinically by Krishaber into intrinsic extrinsic and

R d b f e th M d l Soc ty f th St te f N th C l Ap l o g g D h m N th C l

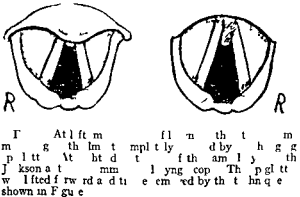


laryngeal cancer. The intrinsic group includes those cases in which the lesion was both intrinsic and extrinsic. These cases were found to present the classical symptoms already enumerated. The intrinsic group included all cancers arising from the cord, ventricular band, interarytenoid region and the subglottic area. Chevalier Jackson further subdivides this group into the anterior intrinsic, including the anterior two thirds of the larynx, and the posterior intrinsic, in cases in which the cancer arises in the posterior third of the larynx (4). The earliest symptom in the anterior intrinsic group is

hoarseness in the posterior intrinsic group, local discomfort and hoarseness. The extrinsic group includes those cancers arising from the epiglottis, arytenoid, aryepiglottic fold, the laryngeal surface of the pyriform sinus and the pharyngeal surface of the cricoid cartilage. The earliest symptoms in this group are local discomfort and dysphagia.

SITE

Cancer may involve any part of the larynx; epithelioma is the most frequent form; sarcoma and medullary cancer are rare. Glandular carcinoma most frequently involves the epiglottis. Contrary to the view of Virchow and Semon, who held that benign growths most frequently invade the anterior two thirds of the larynx and malignant growths the posterior third, Sir St. Clair Thomson has shown that the anterior two thirds is the most frequent site of the primary lesion in cancer (11). This area corresponds to that area involved in the anterior intrinsic group of Chevalier Jackson and is that portion of the larynx in which lymphatic leakage occurs late. The fact as established by Sir St. Clair Thomson that the anterior portion of the larynx is the most fre-



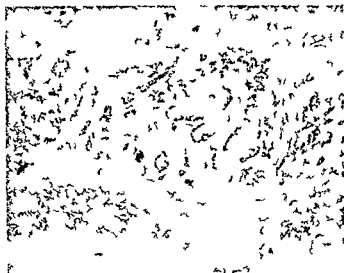


Fig. 3. Photomicrograph of tissue removed from the larynx illustrated in Figure 2b. Twenty-four hours after the specimen was taken Herbert Fox reported squamous cell epithelioma.

quent site of cancer is of the utmost importance because with early diagnosis this site is the most favorable for cure.

#### LOCAL APPEARANCES

Local appearances vary according to the location and stage of advancement of the growth; the presence of superimposed inflammatory reaction and ulceration. Seldom is the appearance so characteristic as to be conclusive. Many types have been described as follows by Sir St. Clair Thomson (10):

1. Persistent congestion and thickening of the cord.

A definite tumor resembling papilloma, fibroma, or angoma, and an irregular infiltration difficult to distinguish from tuberculosis and syphilis.

3. A limited infiltration cupped or retracted in appearance.

4. A defined tumor, single, sessile, white and reddish gray, and warty looking.

5. A fringe-like border, white in color, giving the cord an irregular appearance.

6. In the extrinsic variety, a dusky red uniform swelling, which is generally a fleshy color with an uneven surface.

7. On the epiglottis, a cancerous growth is irregular, grayish white, dusky red, or dirty white in early ulceration.

Local fixation of the part involved indicates deep infiltration and advancement of the le-



Fig. 4. Tissue removed at larynx fissure (actual size). Within 48 hours after removal of the specimen for biopsy, a wide margin of normal mucosa surrounds the growth. The patient is now well with a good voice 16 months following operation. Arrow indicates anterior commissure (Crawford).

sion. In many cases we have found on biopsy the local lesion cancerous when there was no local fixation on mirror examination.

Considering then the wide variation in appearance on mirror examination and the many and variable factors in the production of these appearances, the welfare of the patient demands that a method of certain diagnosis be employed early before the disease has extended and the chance for operative cure is lost.

#### DIAGNOSIS

Given a case of ulceration of the larynx in an adult, the 3 etiological conditions to be considered are tuberculosis, syphilis, and malignancy. It is generally agreed that tuberculosis of the larynx for all practical diagnostic considerations is never primary (9). Then the finding of an ulcerative lesion of the larynx with an appearance suggestive of tuberculosis, with the finding of positive evidence of a pulmonary lesion, is very strong presumptive evidence of laryngeal tuberculosis. In syphilis of the larynx, the positive serological reaction and the evidence of syphilitic disease in other organs, the favorable effect of a therapeutic test with antisyphilitic medication on the laryngeal ulceration, and the suggestive appearance on mirror examination are strong presumptive evidence of syphilitic ulceration of the larynx. It must be remembered however that malignant disease of the larynx, particularly in a syphilitic subject, may respond favorably for a time to antisyphilitic therapy. It is also well to remember that an acute edema of the larynx may be precipitated by the



I 6 I t m ph f t m d f m th  
l y f m 3 f h l d t t l  
f l l m t \ il f m l y (C f l)

administration of potassium iodide to a patient with an ulcerative lesion of the larynx. A provisional diagnosis of malignancy of the larynx can then be made in an adult patient when all evidence of tuberculosis or lupus are negative and the appearances are suggestive of cancer remembering however that malignancy may coexist with syphilis or tuberculosis or that it may occur in a tuberculous or a syphilitic subject.

Every case should be thoroughly studied; a positive diagnosis should not be made on mirror examination alone. That uncanny diagnostic sixth sense which does not depend upon the teachings or the literature for its inspiration, so well evaluated by William V. Mullin in "Diagnostic Limitations in Laryngology" (7) and so adequately defined by Dr. D. Bryson Delavan as a subconscious reasoning based upon long experience of many closely observed cases (7) should be developed by every laryngologist for as Dr. Delavan further says: "The beginner does not have the instinct for diagnosis. The man of long experience may acquire it."

In addition to this in every case of early cancer of the larynx the conclusive diagnostic step should be biopsy. If biopsy is negative for cancer the specimen removed may afford



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evidence of some other infectious or neoplastic condition of the larynx either on culture or histological examination. If negative repeated specimens should be taken at proper intervals and under proper aseptic precautions until conclusive evidence is obtained. By the use of the Jackson anterior commissure laryngoscope under local anesthesia with only slight discomfort to the patient a specimen can be removed with accuracy from any portion of the larynx that is desired (Figs 1 and 2). A histological report can be obtained by the quick method in 24 hours (Fig 3) and if the growth be malignant the surgical procedure adequate for the removal of the growth can be instituted within 48 hours (Fig 4). Dr. Baxter L. Crawford states: "The examination of a number of the larynges removed by Doctor Lewis at laryngectomy showed no evidence whatever of metastasis as the result of biopsy, although in many instances the patient had refused laryngectomy for several months following a positive report from biopsy (1)."

In the examination of the larynx with the mirror we see only the surface of the lesion. In early cancer the appearances are not characteristic and the important thing to know is



Fig. 7 Photomicrograph of tissue removed from the larynx of a man age 55 years showing mucous membrane markedly thickened epithelium hyperplastic and the submucosa of the epithelium suspicious of malignancy but no definite evidence of malignancy (Crawford)

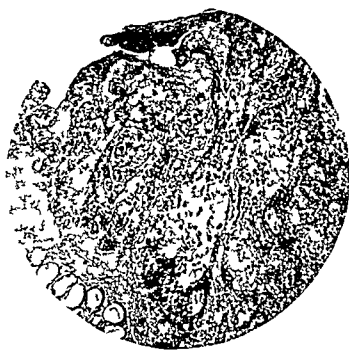


Fig. 8 Photomicrograph of tissue removed 3 years later from the same larynx as in Figure 7 showing mucous membrane ulcerated epithelium markedly hyperplastic and definite evidence of infiltration into the deeper structures. The infiltrating epithelium shows considerable differentiation and many mitotic figures. There is marked inflammatory reaction of submucous tissue. Squamous cell epithelioma (Crawford)

what the deeper cells are doing. This can be determined only by biopsy. Biopsy reveals another very important class of cases. The lesion in this class was described by Chevalier Jackson and designated clinically as precancerous (3). Time will not permit a discussion of the evidences presented by Doctor Jackson of the precancerous conditions but the evidence is conclusive that cancer develops following non malignant lesions in the larynx. Sir St Clair Thomson quoting Semon states: "A malignant degeneration of a benign neoplasm may occur" (10). Our pathologists often report to us that there is a suspicion of malignancy in the specimen of tissue examined. Chevalier Jackson quotes Dr. James Ewing after his examination of one of these specimens as saying: "This is the stage in which to treat cancer of the larynx, not after it gets well advanced" (3).

From our tabulation of the last 250 cases of cancer of the larynx at the Chevalier Jackson Bronchoscopic Clinics I wish to report 2 cases from the group in which existed a non malignant lesion which seemed to be an etiological factor in the later development of cancer.

CASE 1. A woman 3 years of age presented a lesion of the larynx, a specimen of which on histological examination showed papilloma and chronic infiltrative laryngitis (Fig. 5). Five years later a specimen from the same patient showed squamous cell epithelioma (Fig. 6). The symptoms of laryngeal involvement persisted from the time of the first examination to the second (Pathologic Reports by Dr. Baxter L. Crawford).

CASE 2. A specimen removed from an ulcerative lesion of the larynx in a man 55 years of age in March 1914 showed marked hyperplasia of the epithelium with suspicion of malignancy but not definitely malignant as reported by Doctor Crawford (Fig. 7). Operative removal of the lesion was advised at this time but the patient refused and on his return February 1917 the specimen removed at biopsy showed definitely squamous cell epithelioma (Fig. 8).

#### TREATMENT

Adequate surgical removal is the only treatment worthy of consideration with the hope of cure of cancer of the larynx. The removal of an intrinsic growth by intralaryngeal surgery is not advisable because of the uncertainty of complete removal.

*Laryngostomy.* After early diagnosis laryngostomy will cure 80 per cent of the anterior



intrinsic case and will give an adequate voice with no operative mortality without a mutilating operation. Recurrences following laryngofissure may be amenable to reoperation by laryngofissure and are always amenable to complete laryngectomy if the patient has been kept under postoperative observation. These patients should be examined by the surgeon who performed the laryngofissure at least every month for the first year.

**Complete laryngectomy** according to John Edmund MacKenty should be done in all intrinsic cases in which there is extensive involvement (6). Dr. Fielding O. Lewis feels that laryngectomy may also be indicated in extensive cases in which the lesion is extrinsic or mixed (5) and in other extrinsic varieties: subhyoidpharyngotomy and lateral pharyngotomy.

The use of radium and X ray is now generally conceded to have no place in the treatment of cancer of the larynx except in some cases as postoperative radiation after laryngofissure or laryngectomy to prevent glandular invasion (12). It may be used also in those cases of cancer of the larynx which are not amenable to surgery because of the location or extent of the growth. Dr. Henry K. Pancoast from his enormous experience at his clinics at the Philadelphia General and the University of Pennsylvania Hospitals states: "I no longer use radium in the treatment of laryngeal cancer except in special cases. Cancer of the larynx is not suitable for radium therapy first because of the resistant nature of the squamous cell carcinoma which is the type most often found; second because of the tendency to necrosis of the laryngeal cartilage after the intensive radiation necessary; third because of the frequently inaccessible position of the growth" (8).

**Tracheotomy.** Tracheotomy for the relief of dyspnea with palliative radiation may be advisable for advanced cases.

#### CONCLUSIONS

1. The earliest symptoms of cancer of the larynx are hoarseness and local discomfort. A persistence of these symptoms in an adult should place the patient under suspicion of cancer and he should be kept under the

observation of an expert laryngologist until a definite diagnosis is made. Mirror examination while the most important method for study is not conclusive and should be supplemented by general examination, X ray examination, serological studies, direct laryngoscopy and biopsy to exclude cancer definitely in a suspicious case. Doctor Jack on says:

Every adult patient with hoarseness should be considered as possibly cancerous until proven otherwise by every means we possess.

2. Early diagnosis will permit a cure by laryngofissure in about 80 per cent of cases.

3. Biopsy by means of the direct laryngoscope should give a positive specimen in every case of cancer of the larynx. But if the specimen is inconclusive or negative it should be repeated while any suspicion of cancer remains. In the hundreds of cases of cancer of the larynx in which a specimen has been removed for histological examination at the Bronchoscopic Clinic we have never seen any evidence of metastasis as the result of biopsy.

4. Laryngectomy, subhyoidpharyngotomy and lateral pharyngotomy will cure a good percentage of the extensive intrinsic and extrinsic cases.

5. In inoperable cancer of the larynx tracheotomy and palliative radiation may be advisable.

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## SQUAMOUS EPITHELIUM IN THE ENDOMETRIUM IN BENIGN AND MALIGNANT CONDITIONS

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SQUAMOUS epithelium in the uterine cavity has been noted so frequently that it has given rise to an extensive literature the main interest in its occurrence being centered on its relation to malignancy. A review of the instances which have been reported shows that all of the cases may be grouped into three categories: first are the cases with a definitely benign process; second those with a malignant condition; and finally a small group presenting certain findings which have given rise to controversy regarding their exact significance.

The normal cylindrical epithelium of the uterus is rather frequently replaced by a type of stratified squamous epithelium of a purely benign character and Veit (43) has given this substitution the name of epidermidization. This change is found principally on the cervix during the healing of erosions and in inflammatory conditions (Fluhmann 8) and also on the surface of cervical mucous polypi (Fluhmann 9). In the endometrium it has been described in a variety of lesions. Zeller (48) in 1885, on the basis of observations made on 63 patients, stated that in chronic endometritis the cylindrical epithelium of the corpus or cervix uteri is very frequently replaced by stratified squamous epithelium. He maintained that this new tissue with its basal cylindrical cells, its numerous transitional forms and its superficial cells without nuclei is similar to that of the vagina and that cornification may occur in its more superficial layers. Considerable interest was aroused by Zeller's statements concerning the so-called "ichthyosis uteri."

Subsequent workers although they found squamous epithelium in a few cases of endometritis have failed to substantiate Zeller's statement as to the frequency of this lesion (Ruge and Gebhard 13, Ries 34) and it has been suggested that there was some error in his microscopic technique. Zimmermann (30) has recently described a case in which he

found on the surface of the endometrium a type of stratified epithelium resembling squamous epithelium. He interpreted his findings as representing a degeneration of cylindrical cells rather than a metaplastic change and stated that this explanation might account for the frequent mention of "ichthyosis uteri" by some of the early authors.

At present the consensus of opinion seems to favor the belief that squamous epithelium is found in the endometrium only in exceptional instances. However it has been described by Klein (23) and Sitzenfey (41) and Schottlaender (39) in a study of 579 specimens found so-called metaplastic changes 14 times in the body of the uterus. Werth (44) states that during regeneration of the uterine mucosa following curettage a tissue resembling squamous epithelium may be found. Hengge (15) believes that it may occur following pregnancy, malignancy or tuberculosis. Bondi (5) and Schneider (38) found squamous epithelium in cases of pyometra and Alterthum (1) noted similar changes with formations resembling cancerous pearls in a case of tuberculosis of the endometrium. Mainzer (24) reports 4 cases in which he found metaplastic changes in the uterus following intra uterine applications of formalin. Francese (10) and Ries (34) describe epidermidization of the endometrium in chronic inversion of the uterus and Herrheimer (16) reports the finding of squamous epithelium on the surface of an endometrial polyp projecting into the cervical canal.

The condition has also been produced experimentally. Dr Erchia (5) caused a retention of products of conception in pregnant guinea pigs by ligating one uterine horn and removing the fetus. Two months later the tissues were examined and he was able to demonstrate a metaplasia of cylindrical to squamous epithelium. Recently Wolbach and Howe (47) conducted a series of histological studies on a number of rats which had



Fig. 1. Squamous epithelium in the endometrium of a child 5 years old.

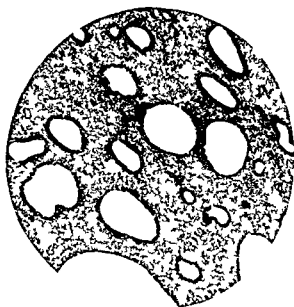


Fig. 2. Squamous hyperplasia in the endometrium of a child 5 years old.

been fed on a diet lacking fat soluble A vitamin and found keratinization of the uterine cavity.

It is of considerable importance particularly in the question of etiology that such changes have been noted in the uteri of newborn and young children. Meyer (8) found areas showing a stratification of cells in the endometrium of a newborn. There were from 4 to 8 rows of cells; the lowermost were cylindrical in shape; the next were cubical and in the most superficial layer the cells were flat and resembled endothelium. Friedlander (12) found islands of squamous epithelium in the uterine cavity of a child 5 years old. More recently Wilson and DuBois (46) described the findings in a child 5 months old who had died from a deficiency of fat soluble A vitamin and found epidermalization of the endometrium in the region of the fundus. Finally, Natanson (9) studied a series of cases and came to the conclusion that squamous epithelium occurred in the corpus uteri in 10 per cent of children up to the age of 2 years and that as a rule it tended to disappear during the further development of the uterus.

**Squamous epithelium occurring in malignant conditions of the corpus uteri** has been discussed many times but still offers numer-

ous unsolved problems particularly regarding its origin and development. It is important to remember however that squamous epithelium does not always have the same significance and that the cases may be divided into 4 distinct groups:

1. Squamous epithelium occurring as a metaplastic process in an adenomatous carcinoma of the uterine cavity.
2. Squamous cell carcinoma coexisting with an adenocarcinoma.
3. Squamous cell carcinoma of the corpus secondary to a similar growth of the cervix uteri.
4. Primary squamous cell carcinoma of the uterine body.

The first group represents a large number of cases and numerous instances have been reported in the literature for example by Frank (11), Hirschmann (18), Zimmermann (49). The active process is a malignant adenomatous growth and the squamous epithelium does not take any part in the destructive and invasive lesion. Hirschmann states that it is of frequent occurrence in glandular cancers of the corpus uteri and not only is it found in primary growths but several instances have been described in which the malignant tumor in the uterus was a

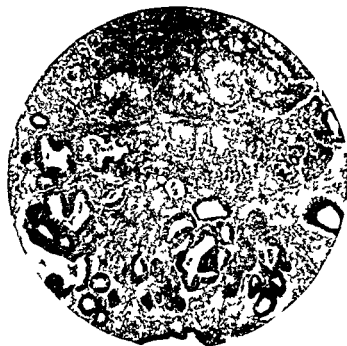


Fig. 3 Islands of squamous epithelium in hyperplastic endometrium Low power



Fig. 4 Islands of squamous epithelium in hyperplastic endometrium Low power

metastasis of an ovarian cancer (Zimmermann 49 Hunziker 5)

The exact mechanism of this metaplastic change has given rise to considerable discussion and there has been some question as to whether the metaplasia occurs from carcinomatous cells or from mature cylindrical epithelium. It has even been suggested that we are not dealing with a metaplastic process in fully developed cells but that both types arise from an embryonic tissue which carries the potentialities of differentiating into either cylindrical or squamous epithelium. Meyer (6) believes that it was definitely established that metaplasia could occur in cells at the surface but that when the process was found deep in glands some other factor must be found to account for it. This has been refuted however by Herxheimer (16) who maintains that no sharp distinction should be drawn between surface and glandular epithelium since they belong together genetically. Hitschmann also states that metaplasia occurs in both. Zimmermann (49) in a more recent review states that a true metaplasia must be considered in some instances but that in the majority of the cases which he has studied the findings were accounted for by a degenerative change in

cancerous cells both in glands and at the surface simulating squamous epithelium. This possibility was also advanced by Keith (2) in 1905 in connection with a case which he reported.

In the second group of this classification is found a rare type of tumor in which an adenocarcinoma and a squamous cell cancer co exist in the same uterus. A considerable number of these double cancers were described by early authors but it is probable that many of the cases really belonged in our first group and that the squamous epithelium simply represented a metaplastic process. Hitschmann (18) claims that the theory of the origin of these tumors from two different matrices must be abandoned. However whether the squamous cell tumor represents a primary growth in the uterus or results from cylindrical cells which have undergone a metaplastic change apparently *bona fide* cases have been described in which cells of both types were found taking an active part in the destructive lesion (Kaufmann 21 Strong 4).

In the third group which includes those cases of squamous cell cancer of the endometrium appearing as a metastasis or direct extension from a similar growth in the cervix



Fig. 5. High power photomicrograph of the fundus of the uterus.



Fig. 6. High power photomicrograph of the fundus of the uterus.

we find the greatest number of cases. In 1911 Maunaf Heurlin (25) collected numerous instances from the literature. This group is of little interest except as regards the various ways in which the condition may occur. In the first place the cancer cells may be disseminated along the lymphatics in a retrograde manner and specimens have been described in which numerous small foci have been found scattered throughout the uterus. The cancer cells may also proceed by direct extension from the original tumor as a destructive process and there is a special form in which the growth remains superficial and spreads over the endometrium. Tuge has given such a condition the name of *ucker guss* cancer. Pfannenstiel (31) has mentioned the possibility of direct implantation on the endometrium from a cervical growth either spontaneously or by instrumentation.

The fourth group of this classification is of great importance for it includes the primary squamous celled carcinomata of the uterine body. This condition is rare and only a few of the cases that have been described have been accepted by subsequent workers as being sufficiently confirmed.

It would seem that three requirements must be fulfilled before the diagnosis can be

considered as absolutely established. First there must be no sign of a co-existing cylindrical cell cancer; second there must be no connection between the growth and the stratified squamous epithelium of the cervix; and third the cervix must have been carefully examined to eliminate an original growth in that organ. These requirements necessarily cast doubt on a number of instances which have been reported in which there was a small growth in the cervix and a larger one in the fundus and in which the interpretation has been that the cervical tumor occurred as secondary to one in the uterine cavity, for example in the case of Schauta (36) and Piering (37). Although it is perfectly conceivable that this might occur it is so much more likely that the primary growth lies in the cervix that these cases must be questioned. The fact that the intra-uterine tumor is more advanced than the cervical growth is no proof as there are many examples of a metastatic tumor exceeding the primary lesion in size.

In 1911 Maunaf Heurlin (25) reviewed this subject very thoroughly, reported a case of his own and only accepted as *bona fide* 5 instances of primary squamous celled carcinoma of the corpus uteri, namely those of

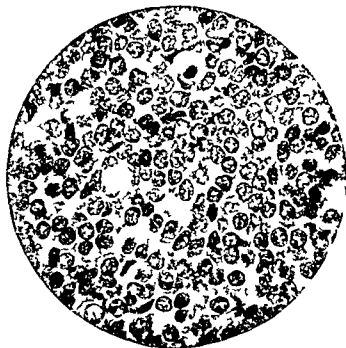


Fig. 7 Photomicrograph showing regularity of cell seen in Figures 5 and 6. Magnification under oil immersion lens



Fig. 8 High power photomicrograph from an area seen in Figure 3 showing tendency of some of the cells to differentiate further into squamous epithelium

Schauta and Piering (36, 32) Gebhard (13) Flaischlen (7) Gessner (14) and Schauenstein (35). In 1909 Cullen (4) considered the cases of Flaischlen and Gebhard as authentic and felt that other instances he had met in the literature (including that of Schauta and Piering) were of a doubtful nature. However specimens which seem to fulfill the requirements mentioned have also been described by Batchelor (2) and Norris (30). Since 1911 5 papers purporting to report similar cases have been published. Hirsch (17) described 3 cases but gave incomplete information and did not mention the findings in the cervix. Williamson and Abercrombie (45) report a case accompanying inversion of the uterus but also fail to give the findings in the cervix. Furthermore the patient had been treated with radium before the specimen was obtained. Schmitt (37) describes a case which is apparently authentic but which was complicated by metastases in the vagina and vulva. The portion of the cervix which was removed at operation was not available for examination.

In 1911 R. Meyer (7) described very unusual findings in the endometrium of a patient 4 years of age. The endometrium

seemed to be normal in appearance except for two areas of hyperplastic mucosa which showed remarkable collections of cells associated with the glands. These cells with their stratification, their polygonal shape and round nuclei suggested squamous epithelium although the cells were not differentiated into definite layers. In some places the cells occurred beneath the cylindrical epithelium, grew into the lumina of the glands and partly or completely filled them. They also extended into the surrounding tissues but as well defined nests of cells and not as a destructive growth. Meyer felt that he was dealing with a benign process although he advised keeping the patient under close observation.

Similar findings have been reported by 4 other authors, 3 of whom considered them as carcinoma. Engelhorn (6) found these cellular masses in a uterine polyp from a woman 3 years of age and diagnosed it as an adenocarcinoma. Sitzenfrey (40) described identical cells associated with an 'adenometritis uteri' in a woman 43 years old and also held that it was of a malignant character. Meyer however had an opportunity of studying sections from both these cases and

states that the findings corresponded to those he described. Tolano (33) saw the same changes in a polypoid tumor of the uterus from a patient 4 years of age and interpreted them as an adenomyoma carcinomatous. The case of Hunziker (30) is of particular interest because he considered it to have a benign nature. The patient had no treatment beyond a diagnostic curettage. In a later communication to Meyer Hunziker states that the patient had remained well for 1 years.

The following case from the Stanford Gynecological Service presents what I believe to be a condition similar to that already described.

Miss A. D., age 34, married, nullipara, admitted to hospital March 4, 1937. She complained of intermenstrual bleeding, which had persisted for 8 years. The periods were irregular, as in consequence of the menorrhagia at 4 years were regular until onset of present illness with moderate backache, mild constipation, abdominal pain. Duration of present illness 1 year. She had had 3 uterine curettages, but later it became regular again at the time of the 1st curettage. She had had 3 uterine curettages, but later it became regular again at the time of the 1st curettage. She had had 3 uterine curettages, but later it became regular again at the time of the 1st curettage.

Physical examination: Temperature 98.8 degrees. Pulse 84. Intestines slightly palpable. Pelvic examination: Uterus 11 cm. Blood pressure 114/80.

Lab. data: Hemoglobin 75 percent. Red blood cells 4,000,000. White blood cells 10,000. Erythrocyte sedimentation rate 6 mm in 1 hour.

Pathological examination: The uterus was enlarged and the endometrium was hyperplastic. The cervix was slightly hypertrophied. The fallopian tubes were slightly dilated. The ovaries were normal.

Operation: A midline incision was made. The uterus was enlarged and the endometrium was hyperplastic. The cervix was slightly hypertrophied. The fallopian tubes were slightly dilated. The ovaries were normal.

total hysterectomy (2) right salpingo-oophorectomy (3) appendectomy. After an uneventful recovery the patient left the hospital on April 9, 1937.

Pathological examination: The appendix was normal. A follicular cyst was found in the right ovary with marked increase of ovarian blood vessels. The right tube showed chronic inflammatory changes. The uterine measure 18 by 6 by 5 centimeters. It was of a firm consistency. The cervix showed a small tear on the right side and there was an erosion of the external os. The endometrium of the lower half of the uterine cavity was grossly normal but in the region of the fundus it was considerably thickened and near the right cornu there were several soft, irregular polypoid projections.

Microscopic examination: Sections of the cervix showed chronic inflammatory changes in the region of the external os. The cylindrical epithelium of the cervical canal was replaced by normal squamous epithelium almost to the internal os (Fig. 1). Various stages of epidermalization noted on the surface but a nodule of the gland were seen. No evidence of malignancy was found.

Endometrium: Sections of the endometrium were taken from every part of the uterus. The general picture found was that of hyperplasia of the endometrium (Fig. 2). The hyperplasia was more marked in the tissue obtained from the region of the fundus. Three sections were shown in a collection of cells (Figs. 3 and 4). One of the sections from the lower part of the uterus just above the internal os, another from the lateral wall near the right cornu, while the third was a polypoid endometrium from the fundus. The cells occurred as well defined rounded vacuoles. They were arranged in a row from the center of the epithelium of the gland and to grow either to the lumen of the gland or to the center of the epithelium.

The glands were completely filled in some instances or partly filled in others. The sections were stained with hematoxylin and eosin. The sections were stained with hematoxylin and eosin. The sections were stained with hematoxylin and eosin.

The nuclei were small and round. The cytoplasm was scanty. The cells were arranged in a row from the center of the epithelium of the gland and to grow either to the lumen of the gland or to the center of the epithelium.

The middle layer of the muscularis was normal. The outer layer of the muscularis was normal. The sections were stained with hematoxylin and eosin. The sections were stained with hematoxylin and eosin.

The differential diagnosis in this case is difficult to make with any degree of certainty and presents several very interesting problems. The first question to be answered is whether we are dealing with a malignant condition or with a benign change accompanying a hyperplasia of the endometrium. Of the authors who have previously discussed the subject three have diagnosed carcinoma and two have favored the view that it is an innocent process. Hunziker's patient remained alive and well for 1 year following a simple curettage and this may be taken as fairly good evidence that it was not a cancerous lesion although there is the remote possibility that an early cancer had been completely removed by the curette. It is also important to note that there has been no demonstrable involvement of the uterine musculature the lesion being definitely localized in the endometrium. A study of the individual cells shows none of the characteristics such as mitotic figures and staining irregularities usually assigned to malignant tissue. Engelhorn, Polano and Sitzenfrey base their conception that it is cancerous on the fact that there is an extension of the cells into the interstitial tissue of the endometrium and maintain that this is a lymphatic propagation. As Meyer points out however this is not *per se* proof that the growth is malignant. The cells are consistently arranged in small nests and do not branch out into the interstitial tissue as does a destructive lesion. Meyer considers it to be an extension similar to that seen in the growth of a simple cyst or a fibromyoma that is it pushes the surrounding tissues out of the way without definite invasion and destruction. Meyer also examined the sections from Sitzenfrey and failed to find certain evidence of a lymphatic propagation while Maunz and Heurlin (25) doubt that Polano's case should be considered as a carcinoma.

I am convinced that the findings in our patient are of a benign nature but have to acknowledge that a positive statement is almost impossible owing to the few observations available and our lack of information in regard to the subsequent history. If then

the condition is not malignant what is the significance of the abnormal cells? Hunziker and Meyer consider them as squamous epithelium and since their origin can be traced to the cylindrical epithelium of the glands the first assumption is that it is a metaplastic change. If that is so it is very remarkable that there should not have been a further differentiation of the cells. As stated before these collections of cells simulate those found under cylindrical epithelium in the process of epidermalization. Here the cells differentiate into a tissue that at first is similar to that of the transitional epithelium of the bladder and then becomes normal squamous epithelium but this only takes place after the cylindrical epithelium has been cast off (Fluhmann 8). In our case the masses of cells were all deep in the glands and one wonders if there would have been mature squamous epithelium had they occurred at a point on the surface. However such an explanation is problematical since metaplastic changes in other benign conditions and in adenocarcinoma show fully developed squamous epithelium deep in the glands.

There has been no satisfactory explanation offered to account for the etiology of this lesion. A study of the 6 cases that have been reported shows that the only factor common to all is that the change occurred in glands of hyperplastic endometrium and it is noteworthy that similar findings have not been reported in any other benign condition. It is also of some interest that all the patients were nulliparous (with the exception that this information is not given in Meyer's case). There were likewise no special features in the clinical history as the symptoms complained of are those usually associated with hyperplasia of the endometrium and consisted mainly of irregular bleeding. The age incidence was variable as 2 of the patients were 43 years old and the others 42, 34, 33 and 22 years of age respectively.

The third group of patients presenting squamous epithelium in the endometrium is thus limited to 6 reported instances. Of these cases 3 have been considered as carcinomatous and 3 as benign lesions. The main characteristic is that there are well



defined collections of small polygonal cells with round nuclei associated with hyperplasia of the endometrium. The chief complaint has been irregular and profuse uterine bleeding. No satisfactory explanation for the occurrence of the abnormal cells has been forthcoming but it is assumed that there is some form of metaplastic change from cylindrical to squamous epithelium. Further study and the investigation of additional cases is necessary before an exact interpretation of this lesion can be reached.

## SUMMARY

The occurrence of stratified squamous epithelium in the endometrium has been described in a number of benign conditions in adults and young children and it has also been produced experimentally.

The findings in malignancy may be grouped into 4 categories: (1) squamous epithelium occurring as a metaplastic process in an adenomatous carcinoma of the uterine cavity; (2) squamous cell carcinoma coexisting with an adenocarcinoma; (3) squamous cell carcinoma of the corpus secondary to a similar growth of the cervix uteri; and (4) primary squamous cell carcinoma of the uterine body.

Six cases have been reported of unusual epithelial masses occurring among glands in hyperplastic endometrium. The lesion is considered to be due to a metaplastic change from cylindrical to squamous epithelium. The exact significance of this change can not be determined but there is not sufficient evidence to consider it as definitely malignant.

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F. H. S. G. S. Th. M. J. F. dat

FROM July 1, 1907 to January 1, 1926, 17381 operations were performed on the biliary tract at the Mayo Clinic. A true cyst of the common duct was encountered only once. One other cyst of the common duct was found but it was not idiopathic and was present in a case in which cholecystectomy had been performed and stones found in the common duct.

Because of the extreme rarity of the condition it is seldom diagnosed. According to the literature the diagnosis has been made preoperatively in only one case that reported by Neugebauer in 1924. In one other case that reported by Wright choledochus cyst was thought of in the diagnosis but was dismissed because of the presence of round worms and a diagnosis was made of possible occlusion of the cystic and common ducts.

According to Lvenson the first case of cyst of the common duct was that cited by Vater in 173. Todd in 1817 reported another case. In these two cases however there is some question as to the pathogenesis of the cyst because of the presence of scirrhous pancreatitis causing obstruction. Since the condition is so rare especially in children and since the patients in the two cases were young they probably should be included. In our series we have not considered any case in which a possible cause for the dilatation might be entertained.

## REPORT OF CASE

A girl 13 years of age entered the Mayo Clinic on January 6, 1927 complaining of attacks of liver trouble. Since infancy attacks of vomiting had occurred with pain in the abdomen mostly under the right costal margin and in the mid epigastrium. In 1922 the appendix was removed after an attack. Five months later a similar attack occurred. Since then there had been from two to four attacks yearly. As the patient grew older the attacks became more frequent and severe and morphine was required for relief. The excruciating pain in the right costal margin passed through into the back and right

shoulder. Residual soreness was characteristic. Jaundice had been present 5 years previously and again 1 year before admission. The stools were clay colored from the last attack. Thanksgiving day 1926.

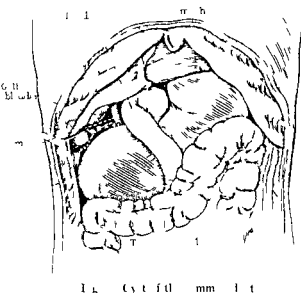
Examination for the most part was negative except for the presence of a movable mass in the epigastrium. There was also slight tenderness at the right costal margin. Examination of the blood and urine was negative. There was no free acid in the stomach. The gall bladder was not visible in a Graham Cole roentgenogram. The coagulation time was 6 minutes, the calcium coagulation time was approximately  $3\frac{1}{2}$  minutes, the blood calcium 9.6 milligrams and the direct van den Bergh serum bilirubin 6.4 milligrams for each 100 cubic centimeters. A diagnosis was made of cholelithic disease probably with stones and operation was advised.

Exploration revealed a congested gall bladder and a cyst of the common duct about 13 centimeters in diameter (Fig. 1). The bile in the gall bladder and in the cyst appeared normal. After a small opening had been made in the cyst for the escape of bile it was anastomosed to the side of the duodenum with silk and chromic sutures. A tube was placed in the gall bladder.

The postoperative period was uneventful and the child left the hospital on the nineteenth day in splendid condition. From the tube within the gall bladder 60 cubic centimeters of bile drained the first day, 10 cubic centimeters the second day and 5 cubic centimeters on the third and fourth days. No bile escaped after the fourth day and on the fourteenth day the tube was removed. The wound healed promptly, the jaundice disappeared and the patient left for home February 28, 1927. A letter written August 1, 1927, stated that she was perfectly well.

This type of enlargement differs markedly from that which is so commonly found as a result of stones in the common duct or in disease of the pancreas. In the latter the common duct enlarges as a whole but retains its normal form and never is much larger than a loop of small intestine. In the former however the middle and upper portions of the duct are dilated enlarging slowly and progressively not unlike a sacular aneurism.

The cysts vary from 2.5 by 3 centimeters in diameters as reported by Heiliger to those



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which fill the entire abdomen and are most commonly described as being the size of a man's head. The terminal or intramural portion of the common duct is as a rule not involved, although Fowler in his case was able to insert the examining finger through the terminal portion of the duct into the duodenum. The position of the cyst varies with its size. The moderate sized cyst usually lies below the liver but may extend in any direction down to the pelvis. The duodenum is forced to one side, the stomach is pushed to the left and is often turned on itself. The ascending and transverse colon are of necessity pushed to the left and downward.

#### ETIOLOGY

The condition is generally considered to be congenital. In support of this theory is Heiliger's case noted in a stillborn fetus almost at term. The cyst in the common duct measured 5 by 3 centimeters. Heiliger concluded that the weakness was primarily in the wall of the duct.

Rostowzew believes that the cyst is a result of an abnormal course of the choledochus through the wall of the duodenum. On several occasions it has been found that the end of the duct instead of entering the duodenum from right to left opens from the front backward

in other words from left to right producing a kink and any obstruction to the flow of bile dilates the choledochus (Fig. 2). Lavenson is not in accord with this explanation and feels that the angular insertion instead of being the cause of the dilatation is a result. He shows that a choledochus lying in the gastrohepatic omentum lies further to the right and that the hepatic artery and the portal vein will prevent dilatation to the left. Since no structures are interposed to the right of the duct it takes the course of least resistance and as a result changes the direction of the duct. He believes however that the underlying cause for the dilatation is a congenital weakness in the wall of the choledochus and follows even temporary obstruction such as a mucous plug or catarrhal cholangitis there is sufficient resistance to the outflow of bile to result in cystic formation and later in angular insertion of the lower portion of the duct.

In Budd's case the ampulla of Vater was on the right and anterior aspect of the second portion of the duodenum instead of on the posterior and internal portion. This he claims is indicative of abnormality in the rotation of the midgut and the peritoneal fixation of the duodenum, all of which might influence dilatation of the choledochus. He believes however that the cysts are due to congenital dilatation of the extraduodenal portion of the common duct increased by valvular obstruction at the lower end by impaction of bile. He suggests that the primary diverticulum is the result of a pancreatic rest in the wall of the common duct, the cells of which break down and a dilatation of the duct follows. He bases this hypothesis on the analogy of diverticulum of the duodenum which often contains pancreatic tissue.

According to Waller the cystic dilatation is the result of a valviform duplication of the wall (Fig. 3). Because the cyst enlarges to the right and downward there is pressure on the fixed portion of the common duct thus preventing the outflow of bile from the cyst. This valve-like duplication has been observed clinically by a number of investigators and explains the intermittent jaundice. This phenomenon would entail the emptying of the sac with disappearance of the jaundice and

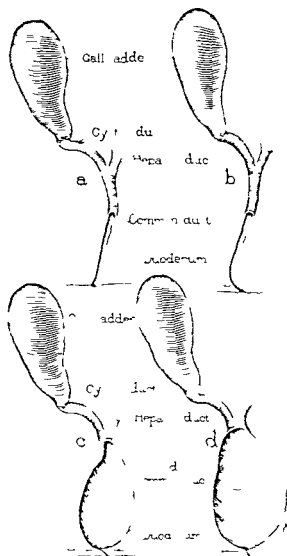


FIG. 2. a The normal course of the common bile duct through the duodenal wall. b, c, d the intramural portion of the duct running from left to right producing an angle resulting in obstruction to the outflow of bile and formation of cyst.

reappearance of the phenomenon with closure of the sac. The emptying and closing of the sac is accounted for as follows. When the sac reaches a certain degree of fullness the left wall presses on the fixed wall of the choledochus so that emptying is impossible. The constant flow of bile from the liver expands the sac further and finally the kink which has been obstructing the duct is freed and the bile is permitted to flow temporarily through the choledochus into the duodenum. Clinically this phenomenon has been reported by Ros towew, Heid and Wettwer who noticed that increase in the size and tension of the sac was followed by reduction of both

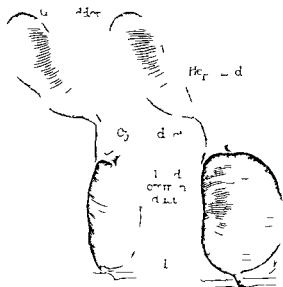


Fig. 3. Uniform duplication of the wall of the cyst with closure of duct. Expansion of the sac and freeing of kink.

Numerous other hypotheses have been advanced as to the cause of the cyst. Certain investigators believe that the muscular tissue of the duct is weak; others believe that there

TABLE 1—TYPE OF OPERATION ON PATIENTS WHO HAVE RECOVERED

Surgeon	Year	Operation
Swain	1894	Aspiration followed by choledochoduodenostomy
Brun and Hartmann	1897	Extirpation of sac by Brun choledochenterostomy by Hartmann
Bake	1906	Primary choledochoduodenostomy
Sternberg	1911	Cholecystectomy and choledochoduodenostomy
Hildebrand	1913	Drainage later choledochoduodenostomy third operation to make a larger stoma
Rutans	1913	Drainage and cholecystectomy 4 months later choledochoduodenostomy
Wall and Kremer	1916	Primary choledochoduodenostomy
Boll	1920	Drainage later choledochoduodenostomy
Krabbel	1922	Drainage later choledochoduodenostomy
McWhorter	1922	Drainage later choledochoduodenostomy
Adams	1923	Extirpation of sac cholecystectomy and hepaticoduodenostomy
Björkman	1923	Drainage later choledochoduodenostomy
Morris	1923	Drainage later choledochoduodenostomy
Zimmer	1924	Drainage later choledochoduodenostomy
Pamperl	1925	Choledochoduodenostomy (primary)
Judd	1927	Cholecystectomy and choledochoduodenostomy

TABLE II—SUMMARY OF CASES

A th	Y	Ag	FE	FD	I p d	T m	E d es l
I l	152	1	17	+	+	A p	1 d d l y l
K k	1	F	1	+	+	1	1 l d y l
S yll	18 8	F	3	+	+	1	1 l l mo h l f m h m
A	1 21			+	+	1	1 ed l l l
H d	1 3	F	14	+	+	Med l	1 ed f m ry l d j h h y t d s c ed ec
S		1	17	+	+	h l l h l j m h	Rec y
E l w h	5	1	4	+	+	1	1 ed l k l f l
1	1	F	3	+	+	1	1 l 4 h l
B oc	7	F		?	?	1	1 ed f m l h cul
B m	18 7	1	3	+	+	1	R y
R	1 7	1	1	+	+	1	1 d l l l
R ll	1 97	M	8	+	+	1	1 l f m h m b 4 d
A h by	18 8	F	7	+	+	1	1 ed f m p e l d l
N l	1	1		+	+	1	1 ed l l y l
D m	1904	1	4	+	+	1	1 ed 3 l y l
C H m m	1904	1	2	+	+	1	1 ed 2 d l
H lg	1 5	M	ll		?	?	Cy 2 5 by 3 m f d ec
K lb	1 80	F	1	+	+	1	1 ed f l l l
R ll	1	F		+	+	1	?
W	0	F	1	+	+	1	C l ec
A ll	906	F	1			1	1 l 2 h l
B k d	19	F		+	+	1	Rec y
C ld mm	1906	1	1	+	+	1	1 ed f h l f h
F b	909	F	18	+	+	1	1 l f m p u h m h
L so	1 09	1		+	+	1	1 l 3 d y l
B	0	M		+	+	1	1 l d l
W	0	M	6	+	+	1	1 ed 2 l l l m h
C l m	191	M	2	+	+	1	1 l 3 y l l f h d lary
S h l m	1	F	7	+	+	1	1 ed f m p 6 d l
b g	1	1	25	?	?	1	1 ed es l f m h
E	1	1	1	+	+	1	1 l f l y l f m h p
I es m	1	M		+	+	1	1 l 2 m h l
H l l b d	1 13	F	1	+	+	1	Rec y l y l
Ipse	3	F	1	?	?	1	1 l m h l f m h
L ll	3	F	2	+	+	1	1 d d y l f m h
R	3	F	5	+	+	1	Rec y
Sch lbe		F	2	+	+	1	1 ed 8 l l
lg	3	1	5	+	+	1	1 ed 8 d y l

F m M Wh b l

f R p d b M y h

TABLE II --(Continued)

A th	Y	Ag	E	P	ope t d g os	T m t	E d lt
R be t	1914	F	17	+	?	D	D ed t A l t
Sm t	1915	F	17	+	F h ococ y t y	E t p t f y t	D ed d d y l t
F l	1916	M	2	+	Acu t h l cy t t	Ch l y tect my l h led	D ed l d y l t f m h
W ll	1917	F	10	+	N	Ch ledochod od ost my	Rec y
W g	1918	F	47	+	M l t m th	Ch ledochod t my th	D l d y l t f m l ed
M C ll	19 0	F	11	+	Cy t fl	D y g l f l t 3	Al 3 y l t
Kz m	19 0	F	18	+	Cy t fl	D y g l f l t 3	Rec y
Sch h l	19 1	F	3	+	F h ococ y t	A p t 3 m th l	D l d y l t f m l ed
B ll	1922	F	13	+	L bscs t t cul d ech	D r g h ledochod od	Rec y
B dd	19	M	2	+	Ch pe t	D g	D l t eck l f m h
Kr bb l	19 2	?	8	+	L bscs h ococ	D t my l t	Rec ry
R l d B ll	19 2	F	5r	+	N	Cy t d ed d t t p t	M l y l t
Y m h	192	F	4	+	t		
Y m h	1922	F	16	+	t		
Adam	19 3	F	31	+	I d t m t	D my l	R y
A bby d l l t t	19 3	F	6.5	+	N	D g t t mpt l f t l	D d f h l t
B hm so	1923	M	3.5	+	R t pe l t m	Ch ledochod os my	R y
M Wb t	19 3	F	49	+	Obs b l d t d t t es	H p t od od t my	R y
M l y	19 3	F	17	+	Cy t f ry	D r g h ledochod od	Rec y
W ight	1923	M	15	+	Block g m n d f y t by d	Ch ledochod od my	D ed 48 h l t
Z pf	19 3	F	12	+	T m t ght ppe q d	D	L l f m pe t t
N g b	19 4	F	21	+	Ch ledoch cy	Ch ledoch l od t my	D l d h l
Zamm	19 4	F	22	+	P cr hyd cy t y f t mes t y t	D g h ledochod od os	Rec ry
f mpe f	19 5	M	4	+	N	Ch ledochod od my	R y
R msay	19 5	F	2	+	Cy k d y ll f r h	D g	D ed h l t
W ll	19 5	F	6	+	N	Ch ledochod od t m	D d 48 h l t
J dd d G	19 7	F	13	+	Ch fecy t t h t e	Ch l d hod od h lcy m	R y

F m M Whort b l t  
 IR po ted by M l y

is congenital narrowing of the common duct as it pierces the duodenum and that as a result dilatation above occurs

Fenger believes that adhesions or an elongated duct cause bending of the choledochus. Syphilis has also been ascribed as the cause of the obstruction. Rolleston reports the case in a child 9 years of age with marked evidence of hereditary syphilis particularly of the liver and pericellular cirrhosis.

Examination of the sac reveals nothing definite. Epithelial lining has often been found on

microscopic examination and elastic fibers muscle fibers and a few glands have been found within the wall.

#### SEX AND AGE

Of the 64 cases on record 50 of the patients were females 10 were males in 4 cases the sex was not given. The average age is 15.1 years but it should be taken into consideration that most of the patients did not present themselves until after the symptoms had been present for from months to 36 years. The

youngest subject was an almost full term male fetus noted by Heiliger the oldest was a woman aged 56 years observed by Peel and Burrell

ONSET

In most cases symptoms appeared before the patients reached the age of 10 many of them were not more than 6 months of age The oldest patient was 20 years of age when the first symptoms were noticed

SYMPTOMS

In certain cases pain was the first symptom in others jaundice and in still others the presence of a tumor in the region of the liver was the first indication of disease Undoubtedly a tumor is the most significant diagnostic factor It may be barely palpable or it may fill the entire abdomen extending from the costal margin to the crest of the ilium In some cases there is no tumor as was observed by Fenger Rotgans McWhorter and Fowler In some cases two tumors were present (Dreesmann Mayesima Arnold Seeliger and Russell) one being a cyst of the common duct the other a distended gall bladder The cysts vary in size and consistency depending on emptying ability It has been noted definitely that several hours after a meal the tumor becomes larger and firmer probably because of the active secretion of bile at this period

Jaundice was the most constant symptom in all the cases reported The degree varied in different cases from a slight icteric tint to severe icterus As a rule the icterus was intermittent but in a number of cases it was continuous In the Guy's Hospital case it lasted 4 years Jaundice was absent in the cases cited by Smit and Bolle Acholic stools were the rule in most of the cases observed Pain varied from simple flatulency of the abdomen to excruciating colic requiring morphine for relief The pain occurred usually in the right upper quadrant often shooting into the back and up into the right shoulder Eating often precipitated an attack In a number of instances however pain was not present Other symptoms of lesser importance were nausea vomiting and diarrhoea sometimes there was fever during an attack

DIAGNOSIS

As has been stated the diagnosis of choledochus cyst has been made pre operatively but once (Neugebauer) The most common diagnosis was echinococcus cyst (Swain Russell Komitzky Brun and Hartmann Rostowzew Dreesmann Kolb Arnolds Goldammer Ebner Lavenson Weiss Schloessmann Letulle Seeliger Smit Schuerholz Bolle Krabbel) A diagnosis was made of pancreatic cyst by Seyffert Arnison Bake Ebner Zimmer of stones in common duct by Fenger and McWhorter of hydrops of the gall bladder by Edgeworth Schloessmann and Lavenson of mesenteric cyst by Bake and Zimmer of malignant tumor by Arnold and Wagner of retroperitoneal cyst by Mayesima and Bohmanson of cyst of the liver by Hildebrandt Smit Kremer Bolle Krabbel and Zimmer of generalized tuberculosis by Broca of chronic peritonitis by Budde of tumor in the right upper quadrant by Zipf of cyst of the ovary by Morley of obstruction of the common and cystic ducts from round worms or possibly cyst of the common duct by Wright of cholecystitis by Rotgans and Fowler of hydro nephrosis by Ramsay and Hill and Zimmer of perforated gall bladder by Seeliger and cholecystitis and stone by us The diagnosis was indeterminate in the case reported by Ashby Nicolaysen Butter Clairmont Sternberg Ipsen Roberts Waller Reel and Burrell Morley Adam Wyllie and Pamperl

The diagnosis should be made more frequently Especial diagnostic factors are recurrent attacks of jaundice with pain in the region of the liver and the presence of a palpable cystic tumor in the right upper quadrant appearing in a young individual especially a young female

TREATMENT

Any type of operation should be carried out that will permit the bile from the cyst to enter the upper gastro intestinal tract One reason for the high death rate is that the condition has been unknown to the surgeon at the operating table The presence of jaundice at the time of operation is another cause for the high mortality rate

Hand b d d ed t cy f th ll bl dd  
I has h y t w f d t p y

In nearly every case in which drainage to the surface was the only operative procedure death resulted. An attempt was made to anastomose the cyst with the duodenum after drainage had been instituted at the first operation by Ashby, Dreesmann, Rotgans, Hildebrand, Seeliger, Schuerholz, Kremer, Brun, and Hartmann, Bolle, Krabbel, Morley, Adam, Bohmansson, and Zimmer. It is of interest to note that Ashby aspirated in his case 10 times before he finally attempted an anastomosis but unfortunately the patient died the day after the operation. Eight of these patients recovered after a second operation had been performed, namely those of Rotgans, Morley, Bolle, Krabbel, Bohmansson, Zimmer, Brun, and Hartmann, and Hildebrand.

External drainage alone was fatal in all but 2 cases. McConnell first instituted drainage by inserting a tube into the cyst. Eight months later the patient reappeared with pain in the abdomen and swelling in the upper quadrant. The abdomen was again opened and the cyst washed. The patient remained apparently well for 2 years before symptoms reappeared. Again the abdomen was opened and the cyst explored. Seven months later the patient apparently was in normal health. Reel and Burrell inserted a tube into the cyst. Three weeks later an abscess formed which required drainage. A fistulous tract persisted for 9 months; the patient was in good condition 18 months after operation.

Marsupialization of the sac has been performed a number of times with fatal results (Letulle, Goldammer, Smit, Lavenson).

Anastomosis between the cyst and the upper part of the bowel was first accomplished by Swain in 1894 when he performed choledochoduodenostomy using a Murphy button.

The first successful primary choledochoduodenostomy was performed by Bakes in 1906. Since then this operation has been performed by Sternberg, Wagner, Waller, Neugebauer, Wyllie, Pamperl, and Judd. Three patients died: those of Wagner, Neugebauer, and Wyllie.

Yamanouchi and others have advised drainage first and later some sort of anastomosis to the bowel. McWhorter, on the other hand, advises hepaticoduodenostomy with partial

or complete excision of the sac whenever possible in order to reduce stasis of bile with intestinal contents and thus lessen the tendency to cholangitis.

The principal cause of death was hemorrhage; other causes were peritonitis, exhaustion, cardiac failure, cholangitis, and shock (Tables I and II).

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# THE RESULTS IN ONE HUNDRED CONSECUTIVE CASES OF HYPERTHYROIDISM OPERATED UPON

A CLINICAL AND HISTOLOGICAL STUDY ATTEMPTING TO CORRELATE THE MORPHOLOGY AND CLINICAL PICTURE WITH A VIEW TO PROGNOSIS

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THIS paper is based on a clinical and histological study of 100 cases of hyperthyroidism operated upon in the Lahey Clinic and followed for a year or more by clinical and metabolic examination at intervals of 2 to 4 months after operation. The cases were selected by taking the last hundred cases operated during 1915 starting in December and working backward. No case in the records was omitted until 100 were obtained.

Our object in this study was first to learn our end results after thyroidectomy in primary hyperthyroidism since the adoption of iodine administration before and after operation in the care of these patients. Second we wished to learn if our clinical impression that low basal rates and myxedema were more frequent since the use of Lugol's solution was correct. The importance of this problem to the surgeon in his decision as to the amount of thyroid tissue to be left at operation is very great. Third we wished to know whether or not postoperative myxedema was related to the degree of lymphoid infiltration (strumitis) present in the thyroid gland. Finally we wished to discover whether one could prophesy the possibility of myxedema (or persistence of toxicity) from the histology of the thyroid gland as evidenced by the degree of involution, the amount of lymphoid infiltration and the presence of acidophilic cells in the sections (Fig. 6).

Relief from the symptoms of hyperthyroidism was complete and satisfactory in 92 per cent of this group of patients. There was one patient whose clinical improvement was marked and whose basal rate was +17 when last seen 3 months after operation and who later committed suicide. We have not included her in the above group of 99 patients. The 7 remaining patients still showed evi-

dence of persisting hyperthyroidism and we cannot class them as cured. All of these 7 however were much improved, all were taking Lugol's solution and all were doing a large part of their usual daily work. The average basal rate for these 7 patients 10 to 14 months after operation was +26.4. The highest of the group was +40 and the lowest +11. Only 2 of this group seem to us to have sufficient hyperthyroidism uncontrolled by Lugol's solution to warrant further removal of thyroid tissue. All of this group of 7 were very toxic on admission to the Clinic and 5 required a two stage thyroidectomy. It can be said definitely that all 7 are much improved over their previous condition even though they are still somewhat toxic.

From our study of these 100 cases we can find no reason to alter our belief that the proper removal of sufficient thyroid tissue will cure the patients of the symptoms of hyperthyroidism.

In these 100 cases of subtotal thyroidectomy the operation was done in one stage in 67 cases, in two stages in 3 cases and in three stages in one case. There was no mortality in this group of patients.

Figure 1 shows the change in basal metabolic rate in this group. The solid line shows the average rate for the entire group before and after operation. The broken lines show the changes in the rate in the patients done in one operation and in 2 or more operations respectively. These curves show the typical drop in basal metabolism which occurs with the use of Lugol's solution and rest in bed before operation. It is evident also that of those patients who in our judgment at the time of operation could not safely have had a subtotal thyroidectomy in one stage all had a higher basal rate both before and after the

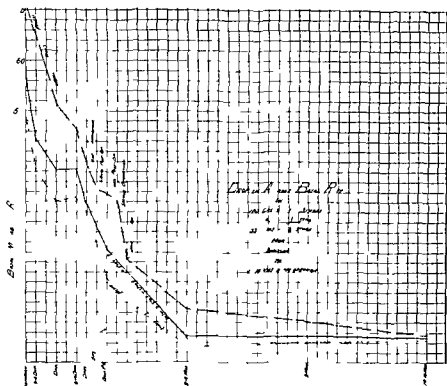


Fig. 1. Diagram of basal metabolic rate.

use of Lugol's solution than the cases done in one stage. Whether the operation was performed in one stage or in multiple stages, however, the basal rate reached approximately the same level a year after operation and examination of the patients shows that the clinical improvement in the two groups is equally marked and satisfactory. Although a one stage thyroidectomy when safe is greatly to be desired from the economic point of view, it is important to recognize that an increase in the number of operations will increase the factor of safety and still produce the same final result.

Of the patients in this series 19 per cent showed a basal metabolic rate 10 to 14 months after operation which was lower than -10. Of these 4 patients had rates of -11, -11, -13 and -15. They had no symptoms that we could detect clinically which were referable to a lowered basal rate. They felt well, worked and played regularly and we classed them as well.

There were 15 patients, however, who had basal rates below -10 who showed definite evidence of myxedema and who were taking

either thyroid extract or thyroxin. The lowest rate in this group was -35, the highest -11, and the average rate was -28 before treatment was undertaken.

The incidence of postoperative myxedema in 13 per cent of the patients is high and we believe that it is much higher than in our previous experience. There are two factors which to some degree account for this increase in myxedema. In 1924 we made a study of our patients showing persistence or recurrence of hyperthyroidism after thyroidectomy and became convinced that we should remove more thyroid tissue than had previously been our custom. In doing this we undoubtedly removed too much tissue in some instances. The decision as to the proper amount of thyroid tissue to be removed or what is more pertinent, the amount of thyroid tissue that shall be left behind is a most important one. It is probably preferable to have a slightly lowered basal rate after operation than one that is persistently elevated. Patients with myxedema do very well with thyroid extract or thyroxin medication although we do not feel that they are entirely

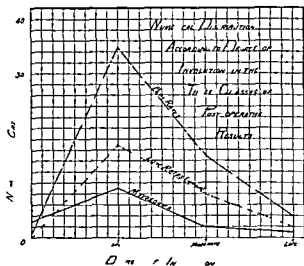


Fig. 2 Numerical distribution according to the degree of involution in the three classes of postoperative results

normal. Weakness and increased fatigability are common difficulties with them often replaced by palpitation and nervousness as the dosage of the thyroid extract is increased. In spite of this fact, however, we feel very strongly that this condition is far more desirable than hyperthyroidism if one could choose between these conditions. The second factor in this high incidence of myxedema is the involution produced in the hyperplastic thyroid gland by Lugol's solution with which we had had relatively little experience in 1935 and prior to that date.

The histology of the hyperplastic thyroid gland shows remarkable changes after the use of iodine. Iodine produces involutionary changes regressive in character. Much of the activity of the gland is reduced and we should bear this in mind when removing this type of gland. It apparently requires more of the involuted thyroid gland to maintain a normal basal rate than it does of the actively hyperplastic gland. Failure to realize this in this series probably accounts for some of the cases of myxedema following operation.

The presence or absence of strumitis in patients with primary hyperthyroidism we felt might be a factor in the etiology of postoperative myxedema. It was the impression that myxedema would not occur after subtotal thyroidectomy in primary hyperthyroidism untreated with iodine and without strumitis and that myxedema might and did occur if thyroidectomy were performed in

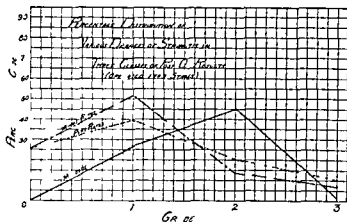


Fig. 3 Percentage distribution of various degrees of strumitis in three classes of postoperative results

cases with marked thyroiditis. The distinction between inflammatory cellular infiltration and lymphoid hyperplasia in this respect is extremely confusing.

We feel that this distinction is one which should be made as far as possible but is one which offers unusual difficulties. It is perhaps almost true to say that fibrosis is an inevitable sequence of lymphoid infiltration of tissues generally presumably as part of a defense mechanism in an effort to wall off an injured area. This obviously interferes to some extent with our interpretation of lymphoid infiltration and fibrous scarring as opposed to simple lymphatism and fibrosis. The chief differential point accordingly is the focal distribution of the lymphoid cells in simple lymphatism as contrasted to the rather more diffuse infiltration of the lymphatic and scar tissue in true inflammatory lesions. Accompanying this is a fairly marked pressure atrophy of the acini in the involved areas in the inflammatory process whereas in the simple lymphoid hyperplasia essentially no interference with acinar function is to be noted.

Of the 15 cases of myxedema there were 8 who showed a basal metabolic rate of +30 or less on admission. Six of these 8 patients had been given iodine for varying periods of time before coming to the Clinic. The diagnosis of hyperthyroidism in these cases was made on the history of increased appetite, loss of weight, eye signs, tachycardia, goiter, tremor, nervousness, etc. Repeated metabolism tests were performed which were

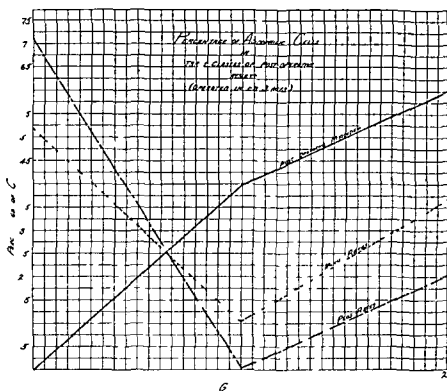


FIG 4 I t f l l l l l l l f t p t r u l t

persistently elevated above a normal level although they remained below + 0. The diagnosis of hyperthyroidism in this group of patients who have received iodine before examination must be carefully reviewed in each case and is often difficult. The true severity of the hyperthyroidism may be so masked as the result of iodine therapy that a fatality or serious reaction unexpectedly follows operation or the diagnosis of hyperthyroidism may be wrongly made because of the belief that the relatively low basal rate is simply the temporary result of iodine medication. In any patient whose basal rate is not definitely and persistently elevated we regard the diagnosis of hyperthyroidism with great suspicion. Many of these patients we now send home for 4 or 6 weeks with orders to discontinue iodine or other medication and to return for further study at the end of that period. We are extremely hesitant to operate on a patient whose basal rate is normal. If however operation is performed in some unusual case in which our clinical findings show very strongly the presence of hyperthyroid

ism in spite of a basal rate but slightly elevated we leave a much larger segment of thyroid tissue behind than has hitherto been our custom.

The 7 other patients in this group had very high basal rate on admission to the hospital but developed myxedema postoperatively. This resulted we believe because of the removal of too much thyroid and the postoperative use of Lugol's solution which reduced the activity of the remaining thyroid tissue.

With the clinical results in mind an attempt has been made in this series of 100 cases of hyperthyroidism operated upon to correlate the histological finding with the clinical picture. Certain of the more outstanding histological features have been tabulated on a gradient scale basis of 0 to 3. Of these it was felt that 3 might be of more probable value prognostically than any others.

For some time we have been trying to correlate the degree of involution of a gland with the clinical finding, measured chiefly by the metabolic rate. Here the figures 0, 1, 2 and 3 have been employed to indicate no change

early moderate and advanced involution respectively. The criteria vary slightly with the personal equation but we have found in our examination of over 2000 such glands during the past few years a surprising uniformity of classification results so that it is only the occasional gland on which we do not independently agree. The important points in this instance are (1) the variation from the high columnar epithelium to the normal low cuboidal cells (2) the size of the follicles and (3) the amount and staining characteristics of the intra acinar colloid. Other less significant features are the amount of papillary infolding of the lining epithelium of the acini and the presence of the so called inter acinar cells of Weber which we do not feel have yet been conclusively demonstrated as existent. We have always considered that these cells merely represent tangential sections of acinar epithelium and the examination of countless serial sections seems to support this hypothesis.

This involution has been plotted numerically in Figure 2 on the basis of the clinical picture and metabolic rate. In other words the degree of involution at the time of operation and then the metabolic rate at the end of the period of observation have been recorded on the basis of cases showing a plus or minus rate with the cases showing definite clinical myxœdema plotted separately. There is no deduction of significance in prognosis to be drawn from a study of this feature. If one translates these figures into percentages in

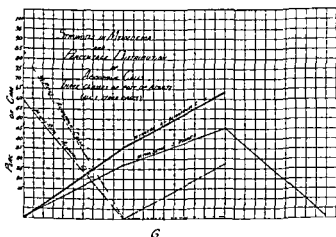


Fig 5 Strumitis in myxœdema and percentage distribution of acidophilic cell. Three classes of postoperative results

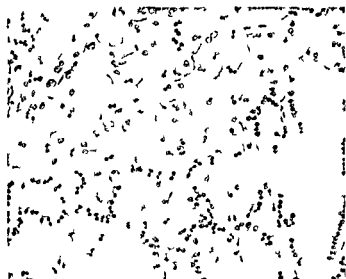


Fig 6 Camera lucida drawing illustrating the acidophilic cell distribution in the thyroid. Primary hyperthyroidism with follicular hyperplasia and nodular hyperplasia. I f N D 515  $\times 300$

each group the curves are practically superimposed. The second feature is based on the amount of inter acinar lymphoid infiltration. Whether or not this represents a true inflammatory repair process or is merely one manifestation of generalized lymphatism is of no importance at the moment. Morphologists have disputed this point for years and no agreement is as yet in sight. Certain it is that in many cases the lymphoid infiltration is sufficient apparently to interfere seriously with acinar function and for this reason it might legitimately be considered as a possible factor in producing hypothyroidism. As in the case of the involution the degree of lymphoid infiltration has been recorded on a 0 to 3 graded scale with 0 meaning no lymphoid infiltration, 1 occasional focal aggregations of lymphocytes, sometimes forming follicles—rarely more than one such group to every 3 or 4 low power fields, 2 frank scattered follicle formation seen in nearly every other low power field, 3 diffuse lymphocytic infiltration with follicle formation obscuring every field. In addition Riedel's type of strumitis essentially a lymphoid replacement of the acini might be termed 4+ on this scale. No specimens happen to be included in this series however.

In the same way as in the case of the degrees of involution the degree of strumitis at

the time of operation has been plotted in Figure 3 against the clinical picture as measured by the basal metabolism rate at the end of the observation period. In this instance the percentage in each group is utilized as it tends to bring out more sharply the fact that incidence of marked lymphoid infiltration is more prominent in the myxœdema group.

The third feature is one about which we have not found any comment. We have been seeing atypical cells usually in small groups often involving several acini which become somewhat separated from the remainder by delicate connective tissue septa. The chief characteristics of these cells are a marked increase in size of both nucleus and cytoplasm and typically a rather intense acidophilic staining reaction of the cytoplasm. Usually they line small acini with hardly demonstrable lumina containing little or no colloid. We have been inclined to call them acidophilic pseudo adenomata and have speculated as to their meaning. Did they play a part in the development of simple adenomata? Were they the precursors of malignancy representing anaplasia? Were they an exhaustion form of the cell? Were they hyperplastic cells compensating for general glandular exhaustion?

These cells accordingly also were tabulated on a 0 to 1 gradient scale without any reference to the clinical history primarily to see if they seemed to be related to any of the other histological variations as well as in respect to the basal metabolism rate and clinical picture.

As a result of this study certain points seem to have been brought out which may be of some value clinically. The degree of involution is of very little practical importance either in estimating degree of toxicity as measured by the basal metabolism rate at the time of operation or as a prognostic sign as to subsequent myxœdema. Many factors enter into the explanation of this discrepancy, chief of them being the difficulty of estimating the amount of iodine administered. Before the routine pre-operative administration of iodine the correlation between the histology and the basal metabolism rate was much closer. Today however the basal metabolism rate usually lags behind the morphological

change but with no given regularity so that marked variations may exist compatibly.

In respect to the degree of lymphoid infiltration there is also very little correlation and we are inclined to suspect that this lymphoid infiltration which is so frequently interpreted as being inflammatory in character may be merely a manifestation of general lymphatism possibly part of the picture of disordered metabolism in which the balance of other ductless gland may be disturbed as we see experimentally in thymic and adrenal dysfunction. At all events there seems to be no essential common relationship between the degree of lymphoid infiltration of a hyperplastic gland (strumitis) and the degree of involution and very little relationship between the degree of strumitis and the subsequent development of myxœdema save in the extreme case in which the differential diagnosis from Reidel's struma or malignancy may be most difficult.

In respect to the third feature—the presence of acidophilic cells—we feel that we have noted an occurrence of more than passing interest and one that may prove to be of some clinical value. Generalizing it may be said with a fair degree of accuracy that in none of the 15 cases which developed myxœdema were the cells absent and in most instances they were to be found in relatively large number. This is illustrated in Figure 4 and 5 in which again the percentage incidence is plotted.

Similarly on the other hand it may be said that out of a total of 36 cases in which a one stage hemithyroidectomy was done in which the metabolism remained +10 or higher after a year only 4 definitely showed the presence of these cells while they were suspected in 2 other cases. In 7 similar cases in which there was no clinical evidence of myxœdema at the end of a year except a minus basal metabolism rate 10 cases definitely showed this type of cell while 4 others were thought to contain cells which might be termed transitional toward this form.

In a smaller group in which the operation was done in two stages the parallel is not so close. There are 20 cases in 10 of them no acidophilic cells were found at either opera-

tion and the basal metabolism rate is over  $+5$  in the 10 remaining cases, 7 showed them definitely in both specimens and interestingly enough showed normal basal metabolism rate  $\pm 0$  and  $+3$  respectively relatively low rates as compared to the series as a whole. Of the 8 other cases 5 showed the characteristic cells only in the first specimen and the 3 others only in the second specimen.

From such data we are perhaps not in a position to draw any very striking conclusions. It seems to us however that we have found these acidophilic cells too frequently to be merely coincidence in the cases which subsequently develop low metabolic rates with or without the clinical signs of myxedema. In a review of these cases in relation to the clinical histories it seems safe to say that almost no case presenting these cells in the histological specimen has shown a persistent hyperthyroidism. Indeed it brings up as a speculative point whether or not the advisability of administering postoperative iodine may not ultimately rest on the pathological report as to the presence and number of these cells for such therapy has been used to prevent hyperplasia of the persistent gland tissue. In such cases perhaps it may be advisable to omit such iodine therapy in the hope of stimulating simple hypertrophy. Similarly may not the decision rest on the pathological report as to whether a second stage operation shall be performed in cases in which the initial specimen shows the undoubted presence of these cells because of the danger of subsequent myxedema? And finally it is as surely true that cases in which these cells occur with any degree of frequency should be more carefully watched for the development of myxedema or lowered metabolic rates and therapeutic measures begun promptly.

#### SUMMARY AND CONCLUSIONS

A clinical and histological study of a series of 100 cases of hyperthyroidism operated upon in the Lahey Clinic and followed for a year or more by clinical and metabolic examination is presented.

Relief from symptoms of hyperthyroidism was complete in 9 per cent of the cases, and

the remaining cases were all much improved confirming our belief that the proper removal of sufficient thyroid tissue will cure the patients of the symptoms of hyperthyroidism.

Nineteen of the patients had a basal metabolic rate at the end of a year of less than  $-10$ . Fifteen of these showed clinical evidence of myxedema. This incidence is higher than in the previous reported series and is probably the result of (1) the removal of larger amounts of the gland than formerly as the result of an undue incidence of persistent hyperthyroidism in the previous series and (2) the administration of iodine after operation to prevent hyperplasia.

Histologically in this series there is very little apparent correlation between the degree of involution and the basal metabolic rate or clinical picture although it is definitely felt that the pre-operative administration of iodine is one of the chief factors in disturbing this relationship. Similarly there appears to be no relationship between the degree of involution and the incidence of either lymphoid infiltration or acidophilic cell formation.

In respect to the lymphoid infiltration there is no very close correlation as regards the metabolic rate in general although there is a somewhat suggestive parallel between the degree of strumitis and the incidence of myxedema.

In regard to the presence of acidophilic cells in hyperplastic glands it may be concluded that there is some relationship between their occurrence and the development of postoperative myxedema as they have been found in all the cases which subsequently developed myxedema. It is not an absolute criterion however for occasional cases of persistent hyperthyroidism contained these cells in the original specimen and we have to estimate the amount of remaining gland before we can decide definitely their significance. We may conclude however that the presence of acidophilic cells is abnormal and is a danger signal not to be lightly disregarded. Their importance clinically with respect to subsequent operative procedures or medical treatment is still problematical but may well prove to be of some practical value.



## CAUSALS OF DIARRH IN ACUTE INTESTINAL OBSTRUCTION

## CLINICAL APPLICATIONS AND GENERAL PRINCIPLES OF TREATMENT

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**H**AUSLER and Foster have recently emphasized the opinion that there are two distinct types of mechanical obstruction of the intestine: (1) acute simple obstruction in which there is occlusion of the intestinal lumen with no circulatory involvement and no damage to the bowel wall and (2) acute strangulation in which there is interference with the venous arterial and lymphatic circulation as well as obstruction of the lumen of the bowel. Their publications in regard to this classification go far toward clarifying the confusion concerning the toxemia and the fatal mechanism of intestinal obstruction. After several months of experimental work during which time we were not acquainted with the work of Foster and Hausler we had independently arrived at a similar classification: (1) intestinal obstruction without gangrene—simple obstruction and (2) intestinal obstruction with gangrene—strangulation. In mechanism as well as in symptomatology the two conditions are entirely different and we feel that this conception enables us to explain most of the discrepancies which have occurred in the observations and conclusions of workers in this field.

## CAUSES OF DIARRH

Our investigations (3) have led us to the conclusion that in simple obstruction of the intestine without gangrene there is no absorption of toxins sufficient to cause death. Death is due to dehydration, loss of chloride through vomiting and starvation. It is for these reasons that the experimental animal with a simple obstruction does not die of toxemia but may be kept alive through the period of starvation by the parenteral administration of sodium chloride solution. An animal however with any form of intestinal strangulation is not saved by sodium chloride solution. In this case dehydration and hypochloremia are present perhaps to a marked degree but

death is due primarily to the absorption of toxin resulting from bacterial action in the distended and gangrenous bowel. Under such conditions transfusions of sodium chloride solution constitute a valuable therapeutic measure but cannot be expected to prolong life indefinitely.

## HISTORICAL REVIEW

In the past 30 years much confusion has arisen from experimental work on the general subject of intestinal obstruction. Obviously the interaction of several factors in part metabolic and in part toxic offer conflicting possibilities and situations difficult to interpret until all the facts are understood. Toxemia has been the chief source of controversy. Following the work of Stone, Bernheim and Whipple (11) the view was held by many that the toxin elaborated by a perverted secretion of the intestinal epithelium. This view apparently has been supported by the fact that experimentally closed loops of duodenum and jejunum rapidly prove fatal unless drained to the outside in which case the animal recovers. Sweet, East and Hendrix (12) attributed the toxemia to the action of the pancreatic enzyme on the proteins present in the duodenum and showed that previous ligation of the pancreatic ducts prolongs life in the obstructed animal.

However, none of the workers excluded the factor of bacterial activity. It is logical to suppose that the intestinal secretions may play a part in that they furnish the culture medium in which bacteria flourish. It is not likely that in themselves the enzymatic secretions are causes of toxemia.

Dragstedt, Moorhead and Burck (2) found closed loops of the jejunum in dogs to be fatal always within 3 or 4 days. If the isolated loop instead of being closed was opened and left opening into the peritoneal cavity those dogs which survive peritonitis remain well. In a

few weeks the loop is found to be sterile and may then be closed without causing toxic symptoms though the loop becomes distended and may even rupture. In these sterile loops the blood supply may be entirely occluded and anemic necrosis develop. In the absence of bacteria this process causes no toxemia.

In 1907 McClure (9) demonstrated that the stagnant contents of obstructed loops form an excellent culture medium which becomes loaded with bacteria. The bacterial content of the loop may be very slight at the time of closure but multiplication is extremely rapid. This rich bacterial growth not only provides the gas which damages the bowel by overdistention but also invades the strangulated tissue causing septic gangrene.

All workers are now admitting the importance of bacteria in producing the toxemia of intestinal obstruction. Gerard (5) has stated that the contents of an obstructed bowel becomes poisonous as a result of the formation of histamine and allied proteolytic products by the action of putrefactive bacteria.

Murphy and Brooks (10) recognize the occurrence of a toxic substance within the bowel but emphasize the fact that absorption of the toxin does not occur through the normal intestinal epithelium. Haden and Orr (6) demonstrated this fact when they produced simple obstruction in dogs and kept them alive for 20 to 30 days by the hypodermic administration of sodium chloride solution. It is possible with such results to assume that sodium chloride has a specific detoxifying action but this view seems improbable.

Further emphasizing the importance of factors which control absorption Dragstedt, Dragstedt, McClintock, and Chase (1) demonstrated that a closed loop of intestine if previously washed with ether was not fatal to the animal. They found the loop contents however to be extremely toxic. Intraperitoneal injection of some of the contents into another dog caused death in 6 hours. The washing of a loop with simple astringents such as alum or tannic acid was found to be equally effective in preventing the symptoms of toxemia. The role of these agents is not bactericidal; their action merely prevents absorption of

the toxin. McClure (9) had recognized these differences in 1907 when he concluded: "Thus if we exclude those conditions in which ulceration of the intestinal wall leads to perforation and peritonitis or in which infarction renders the wall permeable to bacteria it seems that obstruction of the intestine may persist for days with strangulation and enormous growths of bacteria in the obstructed loop."

The failure to keep these points in mind has caused many workers to draw conflicting conclusions from results in which proper explanation reveals no conflict. Discrepancies have arisen chiefly because numerous workers using different methods have emphasized different phases of the subject. The factors leading to the production of the toxin must not be confused with those which control its absorption.

#### DISCUSSION

In our experience with obstructed closed loops of the jejunum and ileum we have always found that death of the animal is preceded by gangrenous changes in the loop due apparently to overdistention resulting usually in perforation along the antimesenteric border. The changes occur much less readily in loops of the lower bowel than they do in the jejunum where the greater secretory activity causes rapid distention. It is for this reason that closed loops of the colon are not rapidly fatal. The loop contents are toxic at any level. The difference lies in the conditions which lead to gangrene of the bowel and absorption of the toxins.

We have found the filtrates from obstructed intestinal contents to be toxic on injection into normal animals. The action is similar to that of histamine. From one dog dying of intestinal obstruction we withdrew by the citrate method 250 cubic centimeters of blood. A normal dog was then bled sufficiently to permit a transfusion of this toxic blood. The result was a temporary violent reaction similar to histamine poisoning with intestinal cramping, vomiting and purging, respiratory distress and circulatory collapse. The animal apparently recovered in a few hours but 3 days later was found to be suffering from an extensive intussusception at the ileocecal junction produced by violent peristalsis.

We may conclude that there develop from bacterial action in the obstructed lumen toxic substances the exact nature of which is not known but which on absorption into the general circulation exert an action similar to histamine. These toxins are not absorbed in lethal quantities from the normal mucosa but with tissue necrosis from overdilatation or strangulation of the bowel the rapid absorption of toxins ensues and is followed by gangrene and peritonitis.

#### CLINICAL APPLICATIONS

It is apparent that gangrene of the bowel is the chief factor which makes intestinal obstruction such a desperate surgical condition. In any case the type of obstruction encountered will depend upon the mechanical factor in force. We feel that a study of these mechanisms will lead to a more accurate conception of this complex surgical problem.

#### CONDITIONS PRESENT IN SIMPLE INTESTINAL OBSTRUCTION

1. Simple obstruction occurs most often high in the intestinal tract at the pylorus or in the duodenum as a result of cancer or cicatricial contraction. From the high obstructions there arises a profound disturbance in the absorption of water and sodium chloride. The resulting dehydration and hypochloremia tend to be rapidly fatal. This is particularly true in the pyloric stenosis from peptic ulcer in which hyperacidity and persistent vomiting lead to enormous losses of chlorides. In cancer or any condition of obstruction accompanied by prolonged achlorhydria the chloride losses are small and these cases may actually become moribund from dehydration without appreciable reduction of the blood chlorides. From a clinical standpoint it is of interest to note that the vicious cycle vomiting which sometimes occurs following a gastroenterostomy is in effect a high intestinal obstruction. In all of these conditions life may be saved and a moribund patient may be prepared to withstand major surgery by the administration of water and sodium chloride intravenously, hypodermically or by any method which permits adequate absorption into the general circulation.

2. Simple obstruction may occur very low in the tract at the rectum or in the sigmoid colon. The low obstruction obviously produces no profound disturbance in the absorption of water and salt. In the absence of bowel necrosis such a condition is compatible with life over a long period of time.

3. Elsewhere in the bowel simple obstruction may occur as a result of neoplasm or fecal impaction. In the small intestine however though the mechanism be simple at the onset the complex loops of bowel and the mesenteric folds almost invariably lead to strangulation.

Clinical experience supports the truth of these statements and failure to recognize the different mechanisms has led to much error in the interpretation of experimental results.

It will be noted that simple obstruction is nearly always the result of obturation by neoplasm or scar tissue. Anything producing obstruction by pressure from outside the bowel is almost certain to cause gangrene.

#### THE FACTORS CONCERNED IN PRODUCING STRANGULATION OF THE BOWEL

A consideration of the question as to the factor involved in producing strangulation of the bowel is of value in understanding the cause of death in most cases of intestinal obstruction and in securing information to guide us in its intelligent treatment. Our experimental and clinical work has led us to conclude that the chief factors involved are (a) necrosis of the bowel from pressure at the site of the obstruction (hernial ring or constricting band), (b) gaseous distention of the bowel and (c) obstruction of the mesenteric circulation.

*Necrosis from pressure.* It is a very common observation at operation in advanced cases of obstruction that the bowel is necrotic directly beneath the constricting band. This is easily explained. Proximal to the obstruction there is great distention of the bowel which produces constant traction on the constricting band. It is evident that traction rather than the mere presence of the band is the cause because the intestine must at one time have passed under the band without constriction.

The fact that the intestine is damaged at the site of obstruction should always be borne in

mind at operation. For this reason greatly distended loops of bowel should never be allowed to escape suddenly from the abdomen. The traction thus produced may lead to a rupture of the damaged bowel flooding the peritoneal cavity with intestinal contents. It is always safer to search for the collapsed bowel and to use this as a guide to the site of obstruction. When it is located it should be exposed with greatest care and gentleness. Before the band is freed every precaution should be taken to prevent the escape of intestinal contents. In desperate cases it is some times safer to ignore the site of constriction and to relieve the obstruction by an enterostomy.

*Effects of gaseous distention.* Gaseous distention results from bacterial action on the stagnant intestinal contents. This is frequently the most dangerous factor in the entire process and the successful handling of this distention is essential in the treatment of any case. That gaseous distention of the bowel can alone produce gangrene and actual perforation was first announced by Kocher (8) in 1898. It has not been sufficiently emphasized by later writers. We have made an experimental study of this condition the results of which are now in the process of publication (4). By actual measurement of the blood flow through freshly obstructed loops we have demonstrated that increasing gas pressure in the intestinal lumen results in a proportionate decrease in the rate of blood flow through the bowel wall. When the gas pressure equals the animal's blood pressure a complete circulatory stasis in the loop results. The ischemia is noted first and becomes most pronounced along the antimesenteric border where the terminal vessels anastomose. We have noted this location of the gangrene and perforation many times at necropsy on dogs with experimental intestinal obstruction.

Aside from this effect of gaseous distention it is undoubtedly true that the pressure increases the absorption of toxins. Murphy and Brooks (10) have shown that toxic absorption takes place rapidly through the lymphatics of an isolated loop when the toxin is introduced under moderate pressure.

That distention of the bowel may exert enormous pressure in the human subject we

have seen strikingly demonstrated in a well advanced case of intestinal obstruction. When the peritoneum was opened through an incision 1 inch in length a distended loop extruded itself and though immediately restrained with gauze packs it ballooned out with sufficient force to split all the outer coats down to the submucosa. From a consideration of the great pressure which gaseous distention may exert we can easily understand the mechanism whereby gangrene so readily complicates any obstruction of the small intestine.

This tendency is greater in the presence of dehydration which causes concentration of the blood and a marked depression of the general circulation. With this mechanism added to gaseous distention, circulatory stasis in the bowel and tissue necrosis may occur much more readily. We have found repeatedly in our animals that support of the circulation by normal salt hypodermoclysis reduces the tendency to the development of gangrene in the obstructed bowel.

#### INTERFERENCE WITH THE MESENTERIC CIRCULATION

The mesenteric circulation is not always involved. It is of chief importance in volvulus, intussusception and strangulated hernia. It is obvious that when mesenteric vessels are compressed the veins will become obstructed sooner than the arteries and for this reason congestion and great swelling will take place. This accounts for the copious bloody stools seen in any thrombosis of mesenteric veins. If this thrombosis is complicated by gaseous distention gangrene and death from toxemia rapidly follow.

#### GENERAL PRINCIPLES OF TREATMENT

The surgical treatment of intestinal obstruction will depend upon the type and duration of the causative factor. An obstruction of simple type unattended by gangrene, occurs characteristically at or near the pylorus and is also found in the early stages of any intestinal obstruction.

The treatment of pyloric or duodenal obstruction should never be regarded as an emergency surgical procedure. Operation should not be undertaken until the dehydra-

tion hypochloremia and cyanosis have been overcome by the intravenous administration of sufficient sodium chloride glucose and water. Under this treatment the prognosis of pyloric obstruction should be favorable.

In the early stage of any intestinal obstruction the same treatment should be followed except that the operation should be done as soon as the blood chlorides have been restored to a normal level. Here also the prognosis is favorable.

Simple obstruction of the bowel may occur as the result of a localized peritonitis involving any part of the intestine. This is a not uncommon occurrence following appendicitis or pyosalpinx and is best treated early in the process by a simple enterotomy and thorough drainage of the primary infection.

Obstruction of the bowel complicated by gangrene calls for special method of treatment. If general peritonitis is already present any treatment is hopeless. Without this complication there is a chance to rescue even the desperate case. The following principles of treatment should be observed:

1. The toxemia of intestinal obstruction is closely allied to that of urgent shock; it is not identical with it. For this reason the patient with true general peritonitis especially either intra-abdominally and should be subjected to the least possible amount of operative trauma.

2. The operation should always be preceded by the intravenous administration of a considerable quantity of physiological sodium chloride solution.

3. An intestinal anastomosis should never be undertaken in the presence of a great distention of the bowel. The semicircumferential incision cannot beuture safely. Furthermore there are fresh surfaces exposed for rapid absorption of toxic material and the paralytic ileus which remains prevents adequate evacuation. An additional factor contributing to the disaster is the initial shock of a difficult operation which may be fatal in a very few hours.

4. The gangrenous loop should be excised and a gun barrel enterostomy performed. When the patient has completely recovered from this operation an intestinal anastomosis can be safely established.

#### GENERAL SUMMARY AND CONCLUSIONS

1. Acute mechanical obstruction of the intestine is of two types: acute simple obstruction in which there is simple occlusion of the lumen without bowel necrosis and acute strangulation in which the obstruction is complicated by the presence of gangrene of the bowel.

2. Simple obstruction chiefly occurs high in the intestinal tract at the pylorus or in the duodenum. In this condition death is not due to the absorption of toxins but is caused by a profound metabolic disturbance resulting from three factors: dehydration, loss of chlorides causing gastric tetany and starvation. In simple obstruction which occurs low in the large intestine the metabolic functions of the bowel are not markedly disturbed and none of the changes is pronounced.

3. In acute strangulation the factors are all present but are overshadowed by toxemia. The toxin is a proteolytic product from the action of putrefactive bacteria in the obstructed bowel. When absorbed it exerts an action similar to histamine. It is not absorbed from the intact intestinal mucosa but makes its way into the circulation through an over-tended bowel and in the event of gangrene the absorption by way of the peritoneal surface is rapidly fatal. In the small intestine practically all obstructions met clinically or produced experimentally are sooner or later complicated by gangrene.

4. In the light of our present knowledge the prognosis of acute simple obstruction should be favorable unless the patient is moribund before treatment is instituted. The metabolic disturbances resulting from dehydration and the loss of chlorides are effectively relieved by the parenteral administration of sodium chloride solution. In obstruction complicated by gangrene this treatment is of value in that it supplies fluid and chloride increases kidney elimination and supports the general circulation. The toxemia however is not relieved by such measure. It is obvious that once a sufficient dose of toxin has been absorbed death is inevitable. The process must be arrested early. The general principle of surgical treatment have been outlined with these points in mind.

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## THE MANAGEMENT OF CHRONIC ENDOCERVICITIS

BY C. JEFF MILLER, M.D., F.A.C.S., NEW ORLEANS, LOUISIANA

CHRONIC endocervicitis is not a subject upon which one can be startlingly original but I make no apology for again presenting this timeworn theme. As Sir Berkley Moynihan once aptly said in another connection much paper and much poverty may co exist and it is not the settled problems of medicine about which much is written but rather those upon which light still needs to be shed.

Endocervicitis as a clinical entity has long been recognized. Its persistence and its intractability to treatment have long been acknowledged. But its full importance is not yet realized nor is it realized that the unsatisfactory results of most methods of treatment are due to the fact that they are directed at the manifestations of the disease rather than at its underlying pathology.

Let it be said at the outset that endocervicitis always demands treatment. This most frequent of all gynecological affections is never a trivial thing. It is potentially serious even when it manifests itself as an apparently local disease. Once it is established a whole train of symptoms may follow arising not only from the cervix but from the uterus and the upper pelvis whence the infection spreads by continuity of tissue or by lymphatic channels.

Thus Curtis has pointed out that the virulent strains of bacteria found in certain cases at least make spontaneous postoperative and postpartum infections eventualities to be dreaded. The work of Sturmdorf, Rosenow, Langstroth, Moench and others would seem to lend both experimental and clinical proof to the theory that the histology and lymphatic structure of the cervix warrant its consideration as a frequent focus of systemic infection. I am not of those who accept this supposition unreservedly but it is folly to deny that in certain cases the sequence of cause and effect is too clear to be overthrown.

Finally there is no doubt that endocervicitis is a condition to which may be truly applied that much abused word *precancerous*. Out of the welter of theories centering about the vexed subject of the etiology of cancer certain indisputable facts emerge. Cancer is always due to the abnormal growth of normal cells and trauma and long continued irritation play a definite part in its production. The relationship of endocervicitis is therefore quite clear. Trauma is a predisposing cause of endocervicitis; the disease itself furnishes the necessary irritation and at least one manifestation of its pathology

—erosion—is akin to abnormal cell formation. Culbertson and Iden have pointed out that certain types of erosion show an extensive proliferation of cells, the development and arrangement of which clearly place the disease on the borderline of malignancy, and Matthews has likewise called attention to the fact that it is but a step from the extreme cell proliferation with orderly arrangement which occurs in marked hyperplastic cystic endocervicitis to the disordered arrangement with embryonic cell found in true malignancy. The soil is plainly ripe for the transition and the actual sequence has been proven too many times to make the caution any longer a matter of doubt.

It is likewise beyond dispute that any condition which can terminate as endocervicitis can in pathology of the upper pelvis in postoperative, postpartum infection or in systemic focal infection and which has in itself the potentiality of a transition to malignancy is not a disease to be ignored or to be regarded lightly.

The most important point in the management of endocervicitis is an accurate comprehension of the condition which must be met. No one method of treatment is applicable to all cases, but any method will fail which does not take into consideration the actual structure of the cervix and the pathology which that structure makes possible.

Two most important considerations in the anatomy of the cervix must therefore be emphasized at this point. In the first place the cervical mucous membrane is composed of complicated racemose glands which empty through small ducts into the canal and it is thrown into definite fold radiating from a central line. In the second place the lymph current may be traced from its origin in the cervical and corporeal mucosa through minute funnel-shaped ostia directly to the myometrium. There it branches into an extensive capillary network which penetrates the uterine musculature later draining into the main collecting channels which course parallel to the uterine and ovarian blood vessels at the base and top of the broad ligament.

The complicated structure of the cervix makes it perfectly evident that its mucosa is

peculiarly susceptible to infection and peculiarly capable of permitting an infection which has once established itself to penetrate deep into its corrugations and to remain latent for long periods of time. It is equally evident that the lymphatic structure of the pelvis furnishes an ideal route for the upward extension of whatever infection has once gained a foothold in the lower genital tract.

Moreover it must be emphasized that endocervicitis is essentially an infectious disease. It is the result of an infection, the result of a laceration, though the two conditions are so frequently coincident that the one can scarcely be considered without the other. The laceration undoubtedly acts as a predisposing cause, the erosion which practically always accompanies it permits the ready introduction of organisms, the surface furnishes a suitable soil for bacterial growth, and the formation of scar tissue interferes with the lymphatic drainage and keeps up a constant unhealthy connection by which infection must enter by some method before the disease can be established.

There then are the facts which must be faced in every case of chronic endocervicitis. We are dealing with an essentially infectious disease, most often of gonorrheal origin, in which the organisms tend to burrow deep into tissue peculiarly fitted to harbor them over long periods of time and in which there is no tendency to spontaneous cure but rather a tendency to upward extension by continuity of tissue or by lymphatic channel. The conditions in the great majority of cases are further complicated by the presence of more or less extensive cervical lacerations. What mode of treatment shall we adopt? Is any one method applicable to all cases?

Trophylaxis is obviously the keystone of the arch. The best way to handle chronic endocervicitis in addition to the prompt treatment of the acute form is by preventive measures. Since it is so constant an accompaniment of cervical lacerations it is plainwise to treat such laceration before they become infected though whether this means that they must be repaired immediately after delivery as advocated by Emge and others is still a disputed matter. Immediate repair

may give good results in the hands of the expert obstetrician who does his work in a hospital under every aseptic precaution but in the hands of the average practitioner such a procedure would probably be fraught with disaster. The intermediate operation, therefore, or repair within a few months after delivery is a wiser routine procedure. The important point, however, is that the lacerations, no matter what plan of treatment is adopted, must not be ignored. There is no longer any valid excuse for the old method of deferring treatment until the patient is past the childbearing period. The potentialities for permanent damage to the pelvic structures are too great to warrant any such course as that. Postnatal care is as important as prenatal observation and many cervical lesions are easily corrected soon after delivery but if neglected may later need radical treatment.

As far as the actual treatment is concerned, certain methods may be promptly disposed of. Even in mild cases local applications are of small value. Only when the organisms are still superficial would such a treatment be warranted and if one remembers the speed with which bacteria travel the futility of such methods in the average case is at once apparent. Even douches are of use only in cleansing the vagina of irritating discharges and lessening local discomfort; they can have little effect on the disease itself.

Autogenous vaccines are only occasionally helpful. Diathermy, ionization, suction, intrauterine lavage, alcoholic injections, injections of pastes and salves, these and similar measures are not always logical; they do not give uniform results and many of them are not free from danger. Curettage is rarely indicated. The trouble lies in the cervix, not in the uterine mucosa, and thorough curettage of the cervix with its complicated glandular structure not only is a practical impossibility but often leads to upward extension of the infection.

Radium cannot be dismissed quite so cavalierly in view of the excellent results reported by several authorities, notably Arthur Curtis of Chicago, who first suggested its employment in endocervicitis. For my own

part, I should hesitate to advocate the general employment of such an agent. If it is used, it must be strictly limited to those cases in which it can be definitely demonstrated that no active or latent infection of the tubes is present and even to an expert such a decision is not always easy to make in the face of a badly infected cervix and the possibilities of an upward extension of the infection.

Cauterization and surgery then remain as the two methods most generally applicable. Mild cases of endocervicitis, especially those seen within a few weeks after delivery and characterized by superficial lacerations and mild erosions, are handled very satisfactorily by cauterization with the small nasal cautery. This is a feasible office procedure and may be done either without anesthesia or with the application of a 4 per cent cocaine solution. Multiple linear incisions are made with the tip and it is surprising to see how quickly a diseased hypertrophied cervix can be converted into a normal healthy organ. Usually, one cauterization is sufficient, but the procedure may be repeated if necessary.

Equally good results are secured when the disease is more extensive if a similar but more radical procedure is carried out under anesthesia in the hospital and a larger cautery is used. It is important to emphasize, however, that these cases must be properly selected. Cauterization is not a panacea to be promiscuously applied to all patients with endocervicitis. It is curative only in the milder infections before extensive fibrosis occurs. In the deeper types it must be done very cautiously for if the incisions are sufficiently radical to strike at the real seat of the infection and the whole cervical mucosa is thereby destroyed, stenosis of the canal is almost inevitable and the patient's last condition will be worse than her first.

In this connection, Matthews's suggestion is a good one that the indications for cauterization may be widened if it is done unilaterally that is, if one lip of the cervix is cauterized and permitted to heal before the other is attacked. It goes without saying that graduated dilatation must be resorted to promptly if there is the slightest evidence of cervical stenosis after the cautery has been used.



If the endocervicitis has originated in laceration of marked degree some sort of surgery is inevitable. Trachelorrhaphy is the preferable procedure because it restores the normal anatomy of the parts and leaves the uterus protected against bacterial invasion by a cervix of normal length and size. However measures must first be taken to eliminate the infection. This is best achieved by a preliminary course of treatment including rest in bed, postural exercises, general hygienic measure, local applications and douche and cauterization and puncture of individual cysts indicated. It is surprising to see how by these means the size of the cervix and the inflammatory reaction can be reduced and how often a seemingly hopeless case is thus rendered quite fit for a simple repair operation. Trachelorrhaphy often fails just because the pre-operative measure are omitted a point long emphasized by Emmett but frequently forgotten by the modern gynecologist.

When even after such a course of treatment faithfully carried out trachelorrhaphy does not seem to promise result the gland bearing area of the cervix must be removed by the Schroeder or the Sturmdorf technique my personal preference being for the latter. These operations are preferable to amputation because they preserve the anatomy of the cervix and rid the body only of that portion of the organ in which the infectious process is located. The results are extremely good provided the operation is done before marked hypertrophy and fibrosis have occurred and the incision is carried high enough to include the entire area affected.

All of the procedures we have thus far discussed permit subsequent pregnancies to occur practically without complications an important consideration in young women. The results of amputation of the cervix are however quite different. Sterility is frequent thereafter and if conception does occur abortion is likewise very frequent if the pregnancy goes to term the dystocia may be very severe. Menstrual irregularities and vague pelvic disturbances are also prone to follow amputation and for these reasons it is well to employ it only as a last resort in women

in the childbearing period when the lacerations are extensive and the infection has proved intractable to other method of treatment. In women beyond the child bearing period these considerations are naturally not so vital but even then I do not advocate its performance without a careful consideration of other possible treatments.

Curtis has recently reported brilliant results in gonorrheal infections merely by keeping the patient away from her original source of contamination his idea being that many times we may regard as a recrudescence of a chronic infection what is really a reinfection. The method certainly has possibilities in endocervicitis of gonorrheal origin though it is useless with irritable and uncooperative patient whose number unfortunately is legion.

#### SUMMARY

1. Endocervicitis is an infectious disease which does not tend to cure spontaneously and the sequelae of which may be extremely serious. Every case therefore demands prompt treatment.

Any treatment to be successful must be directed toward the underlying pathology rather than toward the manifestation of the disease and this pathology cannot be clearly realized unless there is an accurate comprehension of the histology of the cervix and the lymphatic circulation of the pelvis.

2. Local treatment is very unsatisfactory and diathermy, ionization, alcoholic injections and similar measure give only partially satisfactory results and are not free from danger. Radium often gives excellent results in selected cases but is too dangerous to be employed routinely.

3. Trophylaxis is peculiarly soon after parturition will avert a large proportion of cases.

4. According to the condition present cauterization, trachelorrhaphy, the Sturmdorf operation or complete amputation must be done although the latter procedure should be avoided whenever possible.

5. Any surgery is best preceded by a preliminary course of treatment the object being to reduce hypertrophy and inflammatory reaction in the structure and to restore the normal relation of the parts.

SURGICAL DRAINAGE OF THE SEMINAL VESICLES AND PROSTATE<sup>1</sup>

## ITS INDICATIONS TECHNIQUE AND RESULTS

By JOHN H. MORRISSEY, M.D., ILLINOIS, NEW YORK  
F m t h J m B h B l y I l t N Y A H p t l

WITH the development of a broader conception of possible focal infection within the genito urinary tract apart from the so called venereal conditions the problem of treating acute and chronic infections of the prostate and seminal vesicles that do not respond to ordinary palliative methods again demands interest and attention. As a substitute for surgical drainage the Belfield procedure direct application through the ejaculatory duct and injections directly into the substance of the gland with various drugs have all been practiced in an attempt to cope with a persistent infection. Kolnick's careful studies of the changed histology of the vas following these injections and a statistical survey of clinical results presented by Kretschmer before the New York Academy of Medicine would seem to demonstrate that vasotomy does not accomplish all that we had hoped and is not 100 per cent effective. Injections into the substance of the gland and vesicles is not entirely without value and offers a field for further study. Some years ago at Bellevue Hospital Dr. J. J. Valentine carried out a series of injections with a serum devised by Dr. Miguel Cano. The results were striking but the method lacked scientific foundation and was dropped among other reasons for want of money to continue the essential pharmacological studies involved.

In the *Journal of Urology* in 1925 Dr. Thomas Stellwagen reported a large series of cases in which 150 injections of aqueous isotonic iodine solution were made. This solution liberates free iodine in the tissues to the amount of 3 per cent. In a recent personal communication Dr. Stellwagen tells of 14 more cases treated by injection of the vesicles. The results were uniformly good and 1 year after discharge no bone pathology was present and no new focus had appeared in the lower genito urinary tract. The essential nature of these injections is a protein reaction and sensitization

There can be no dispute as to whether the seminal vesicles and prostate will harbor an infection indefinitely. The very practice of massage injection vasotomy irrigation etc. all indicate an attempt to deal with this infection. The objection to vesiculotomy was that all pockets were not effectually removed and to vesiculectomy that it was invariably followed by sterility and in some cases impotence. Several years ago Huet showed experimentally that bacteria were present in the seminal vesicles of healthy animals and he was also able to find the specific organisms in the secretions of the vesicles in animals dying of acute sepsis.

It is variously estimated that from 4 to 10 per cent of all infections maintain an active focus in and about the vesicles. These are the cases that have troubled us and they bring us therefore to a consideration of the merits of operative procedure.

Discussion is also pertinent at this time because of the importance attached to latent prostatic infection in a variety of conditions. Von Ickum of the Mayo Clinic in a study of the focal scope of prostatic infections has demonstrated the relationship between these infections and a variety of disorders including in their relative frequency such remote disturbances as arthritis spondylitis calcaneal spurs peripheral neuritis sciatica and fifth nerve disturbances myalgia and neuromuscular pains eye infections—chiefly iridocyclitis and neuroretinitis secondary urinas vasomotor skin conditions such as urticaria and angioneurotic oedema erythema multiforme dermatitis fever of the so called undetermined temperature backaches abdominal pains chiefly of the lower abdomen functional gastric complaints and peptic lesions of the stomach and duodenum. We must therefore accept this problem by which the relationship of focal prostatic infection and urinary tract disease is linked up more closely with general

systemic disturbance and be prepared if justified to institute radical measures in the same degree as would be used in the handling of tonsillar antrum and sinus and dental infections for bacteriologically focal infection of prostatic origin is essentially the same as that from teeth and tonsils.

Heretofore the failure to locate gonococci within the vesicle or prostate of patients operated upon was deemed of some significance. We know now that in patients who give no history of a previous urethritis an infected prostate will show the same strain of streptococci as is found in peritonsillar abscess, tonsils and muscle. Inoculations in this group of cases have shown prostatic localization and electivity in 70 per cent of the male rabbits injected whereas the control injections in female rabbits showed less than 10 per cent localization in the cervix.

Therefore with this conception of the problem of a focal prostatic infection this type of infection not only in a primary form but secondarily as the result of a gonorrheal infection consideration should be given to a rational method of drainage in cases in which it may be deemed advisable.

Interference with drainage may be epitomized as the basis of symptomatology in all excreting viscera but the seminal vesicle for some reason have been considered as insulated against the necessity of surgical drainage. Interest in seminal vesicle and prostate operations to remove focus of infection has shown only sporadic activity. Some 30 years ago Eugene Fuller of New York performed a number of drainage operations and although he reported favorable results his conclusions were more enthusiastic than accurate and he must be credited solely with drawing attention to this important field. We know that he could not have entirely drained the vesicles with the operative procedure followed. Later about 1910 or 1914 Squier was most active and 5 years later Cunningham of Boston but this enthusiasm has subsided with the demands of an increasing private practice and withdrawal from active clinical work. It is true that seminal vesicle infections particularly in their joint manifestations have a certain economic significance. Gonorrheal rheuma-

tism in particular seems limited to the type of patient frequenting the municipal hospitals and in an average or high grade practice one rarely meets incapacitating joint infections. Then too operations for drainage of the prostate and seminal vesicles suffer a disfavor in common with methods for perineal prostatectomy because of the anatomical difficulties involved and it is perhaps unfair to expect recognition of the value of this method of drainage from those of us who see in perineal prostatectomy nothing but a technical operation which offers no advantage over suprapubic method of removal. In other words it is difficult for one who has not observed the increased ease of convalescence after perineal prostatectomy to comprehend how through a perineal wound complete dependent drainage is secured and an unusual facility provided for irrigation and the other details of surgical after treatment.

In the past 5 years at Bellevue Hospital there have been an average of 88 patients admitted yearly suffering from gonorrheal rheumatism. The average hospital stay of the disease was 38 days. In the City Hospital there have been an average of 3 cases yearly with an average residence of 42 days. Comparing the disease with the residence of about 140 cases operated on we find that the term of hospitalization is reduced to an average of 3 weeks and in 5 per cent of the cases to weeks. In addition routine treatment is facilitated and improved results are obtained in the form of relief from symptoms in much shorter time than with the usual form of therapy by means of cast vaccines and prostatic massage.

The question therefore in rheumatic cases is whether operation for drainage of the prostate and vesicle is effective in diminishing the hospitalization of these cases without unduly increasing the risk and making it greater than that found in some other form of treatment.

Exclusive of the tuberculous type cases for operative measure may be divided into 3 groups: first acute suppurative processes involving the prostate and vesicle and designated commonly as prostatic abscess; second a group with acute or chronic joint changes



Fig. 1. Showing the dissection of the central tendon just before the bulb has been retracted anteriorly. 1. Retractor in place. Testicles held by gauze. 2. Line of incision.

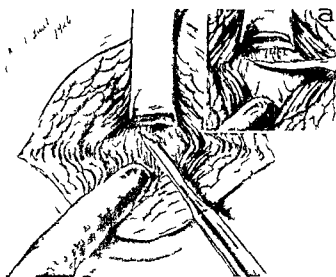


Fig. 2. Showing the prostate covered by the fibers of the urethral muscle and the method of removing these fibers from the surface of the prostate. The bulb is retracted anteriorly and the edge of the levator ani can be seen to either side. In the insert the prostate is shown after these fibers have been removed and the organ has been partially denuded. It will be seen that the characteristic white fascia has come to view.

and third a group comprising the variety of systemic disturbances quoted above in which a definite prostatic infection has been demonstrated. In the first group there is usually no difficulty in demonstrating an immediate relationship between the original gonorrhoeal infection and the onset of symptoms. In the other groups one must arrive at the prostatic infection by exclusion inasmuch as teeth and tonsils are far more likely foci and should first be eliminated. In this respect the association of a double infection is of importance and often the removal of one focus lifts the strain from the recuperative powers of the individual so that he overcomes the second. Arthritic cases treated at Bellevue Hospital before being placed in a cast are given a careful examination for dental and tonsillar infections. When such foci of infection are removed the prostatic infection often subsides to such a degree that the joint symptoms disappear.

The connection between perirectal and ischio-rectal abscess and chronic infection in the seminal vesicles is a very important one and very frequently overlooked. Several years ago Herman published a summary of several cases of pelvic suppuration in males and at that time stated that the seminal vesicles were undoubtedly the starting point of the

infection. Ischio-rectal abscess is rare in the female unless secondary to a rectal lesion and the type of case seen in the general hospital ward is seldom met with in private practice. The course of these cases is a short one. The patient enters the hospital with a swelling over the ischio-rectal space which is incised and the patient is discharged. The history is brief and the study of the cases minimal. Ischio-rectal abscess is treated most lightly in the textbooks on diseases of the rectum in fact in considering the etiology each author seems to have borrowed it from a fellow author because almost to the word reference is made to fishbones fragments of paper and unusual traumatism such as prolonged walking or horseback riding as exciting causes. In a study of the termination of 100 of these abscesses Sejord reports that 35 per cent of his series perforated the urethra an indication that the infection burrowed forward and penetrated the dense capsule of Denonvilliers. These infections start in the tip of the seminal vesicles or in some perivesicular area and instead of going forward burrow posteriorly. Added infection with bacillus coli occurs and it may travel through the superior pelvirectal space pushing the peritoneum before it and making an opening into the right

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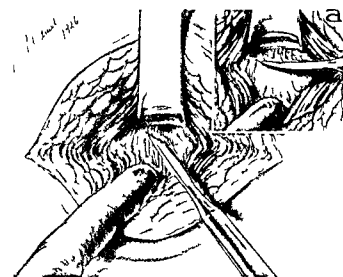


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charge the prostate remains swollen and tender and the joint symptoms are ever draining should be instituted.

In the past 6 years we have operated on 64 cases of acute prostatitis and seminal vesiculitis. In addition 14 cases of chronic seminal vesical infections have been treated by epididymectomy. Twelve cases of extensive peripelvic prostatic suppuration have come to my attention and have been operated upon. These last cases had developed perirectal and superior perivestretal abscesses. It has been difficult to obtain follow up information from the patients with joint affections as most of them were municipal hospital and state hospital cases. The immediate effects of operation in the other cases have been (1) disappearance of pain and swelling (2) subsidence of fever and (3) decrease in size of prostate and perivesicular swelling and tenderness.

To date we have had no recurrence of prostate symptoms and no urethral symptoms. Unfavorable results were not noted except that in 6 cases the patients developed severe chills and 2 became very toxic. The latter afterwards had brisk easily checked hemorrhage from the wound. In none of the cases did a fistula develop.

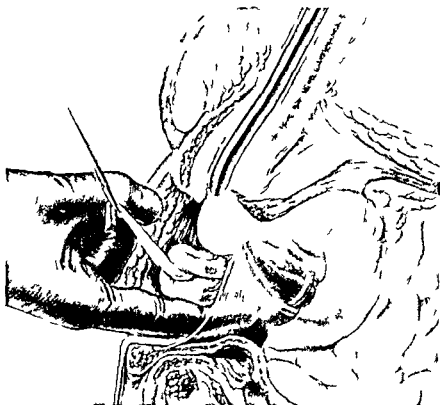
In comparison with the cases of prostatic abscesses which ruptured into the urethra and developed prostatic diverticula with their annoying symptoms this form of treatment in my opinion is to be preferred. Following operation in the rheumatic cases striking results have been noted. In about 80 per cent of the cases there is always a disappearance of pain joint swelling disappears and function returns. The relief from pain is sometimes unbelievably spectacular. Occasionally if drainage diminishes or is interfered with the symptoms may again appear but this condition can be relieved by adequate dressing and probing of the wound. In cases in which x-ray examination has shown actual cartilaginous destruction and bony hyperplasia a return to normal cannot be expected. The acute process within the joint subsides and there is a gradual return to function. If the symptoms do not subside some ureteral infection probably was not adequately drained.



Fig. 4. Frontal section of the prostate and seminal vesicles. The prostate is shown in the center, with the seminal vesicles located superiorly and laterally. The ureters are shown entering the bladder from the superiorly.

Attention should be called to the existence of seminal vesical infection in case of enlarged prostate. The persistence of the infection after prostatectomy may account for the delayed convalescence in these cases. In this connection at the International Urological Congress in Rome in 1914 Sir J. Thomson Wilker described a method of transvesical vesiculotomy and vesiculectomy. He called attention particularly to seminal vesiculitis in senile enlargement of the prostate due to septic catheterization and stated that persistence or urinary infection after prostatectomy was due in many cases to a vesical infection. During convalescence from the prostatectomy or after the bladder wound has healed in such a case there is a rise of temperature with perineal and rectal pain. If normal urination has been reestablished there is often some difficulty and there may be retention of urine. Palpation through the rectum shows that the seminal vesicles are enlarged and tender. A sudden discharge of pus in the urine is followed by a drop in the temperature and disappearance of the symptoms. Recurrence of the attack may require perineal drainage. Sir Thomson Wilker believes that vesiculectomy is indicated at the time of





The Scrotal tube is the first of the four tubes. The first tube is the scrotal tube, the second is the testicular tube, the third is the epididymal tube, and the fourth is the vas deferens. The first tube is the scrotal tube, the second is the testicular tube, the third is the epididymal tube, and the fourth is the vas deferens.

operation if the infection is known to be present and that the vesicle should be removed simultaneously with the prostate. If the condition of the patient is unsatisfactory, however, the vesicle should be laid open and allowed to drain into the bladder. In case of chronic infection contributing to other symptomatology such as joint infection and referred or distant pain operation should be the first resort in treatment and sound judgment should be exercised in the selection of cases.

In extensive studies of infection in the genital system Baumgarten was able to show that tuberculous spread in the direction of secretion. From the original infection the process is borne by the blood stream from the epididymis to the seminal vesicles and the prostate. This is an important point in explaining the etiology of persistent vesical infections in which the condition accompanies or follows an earlier epididymitis. The infection apparently

remains existent in the epididymis and either along the lymphatic or directly through the blood stream a degree of infection is delivered into the vesicle which in turn produces the main symptomatology.

In such cases removal of the original focus may be very beneficial and is quite likely to cure both the vesical and prostatic infection. I have a case so operated upon in which the epididymis had been involved originally and showed slight thickening and nodular formation. Following an epididymectomy there was a complete disappearance in every case of the prostatic and vesical infection and a disappearance of all the systemic manifestations due to the infection. In the case the vas deferens was usually blocked off and the epididymis itself showed a marked degree of nodular thickening with fibrosis. In several cases some abscessed areas in the specimen were also removed. A case illustrating this type is as follows:

D. J. N., 31 years of age, referred by Dr. J. M. Bolster of Providence, Rhode Island. General health had always been good except for two attacks of gonorrhea 7 and 4 years ago. The original attack was complicated with right epididymitis which subsided without operation. Convalescence at this time occupied 14 days. Epididymitis slowly subsided. The second attack occurred 4 years ago with a return of the epididymitis and marked prostatic and seminal vesicle symptoms. The epididymitis was treated by support and hot applications; no treatment was given the prostate or vesicles. Discharge continued for about 6 months following disappearance of epididymitis and has not responded to the usual methods of treatment. Recently the patient has been unable to gain weight and is about 10 pounds below normal. He suffers from moderate depression and lack of strength and complains of pain in the back, slight difficulty on urination and a moderate degree of functional impotence.

Examination showed blood pressure systolic 90 and diastolic 60, urine specific gravity 1012, slightest possible trace of albumin, no sugar or casts, numerous pus cells and epithelial debris, no red blood cells. Rectal examination: Prostate is boggy and swollen. Both seminal vesicles are enlarged, particularly the right one which is nodular and surrounded with considerable perivesicular thickening. Smear of secretion expressed from prostate shows numerous pus cells. Vesiculectomy was done at St. Joseph's Hospital, Providence. The vesicula was dissected away from the testicles. The tissue was hard and cicatrized. Most of the normal tissue had been replaced by organized exudate. An uneventful recovery followed. The patient immediately noted an improvement and after 6 months his condition was much improved. He had gained 11 pounds in weight and showed a marked increase in strength and ambition. Seminal powers were normal; the prostate was firm and the vesicles were non-painful. The patient was seen 3 years after operation and had had no return of symptoms. His general condition was excellent.

As regards recurrence of symptoms after operation, it has been observed with respect to all the complications in neisserian infections that the identical complications are likely to ensue. In other words, if joint symptoms are met with in an initial attack, joint tenderness is noted in each recurrence. So too with an epididymitis which if present with the original infection may be expected to give symptoms with each recurrence.

As to the pathology, it would seem that the essential factor in these conditions is the extension of infection along the ejaculatory ducts and into the perivesicular and periprostatic tissue. Resolution undoubtedly occurs in

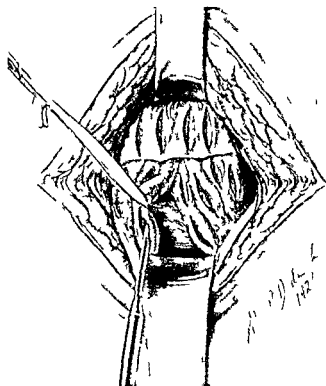


Fig. 6. Showing multiple incisions in the prostate, seminal vesicles and vas.

over 90 per cent of the cases of perivesiculitis and periprostatitis as is evidenced by the infrequency with which many of these cases come to operation. Adhesions in the inflammatory area compress and contract the vesicles and this in itself, while accounting for a great proportion of the cases showing symptoms of vesiculitis, undoubtedly prevent the extension of subsequent infections. In a moderate number of cases, however, local resistance does not develop and a low grade of inflammatory process sets up and slowly produces an exudate. The periprostatic and perivesicular fascia becomes invaded with a thick exudate which, as it is resolved, causes the fascia to become rather leathery. If the process extends forward, the trigone itself may become involved and, as resolution becomes complete, the trigone contains a considerable amount of connective and scar tissue which interferes with its function. A cystoscopic examination in these cases is usually negative except for a slight congestion of the bladder mucosa. In other cases, the infiltration may be sufficiently extensive to involve the urethral orifice. Mathe has so reported a



Fig. 7. Sh. g. l. t. s. t. f. t. l. l. l.  
method of solution of the duct

case and numerous instances are seen in tuberculosis.

The lesion caused by an inflammation may in very light grades be confined in some cases to the epithelial lining of the sac. In more severe ones it may cause a cell infiltration into the walls of the sac occasioning, in recent cases, a tumefaction of the walls and in long-standing ones a sclerous condition. In the more extreme cases the inflammatory changes invade the loose connective tissue round about the seminal vesicles. In severe cases this perivesical invasion may be sufficient to fill up the entire postprostatic rectovesical space. Under such conditions the inflammatory exudate generally infiltrates forward into the fibrous capsule of the prostate encasing that organ in a hard layer of incrustation. In this type it is impossible by rectal examination to

distinguish the prostate or the seminal vesicles, as all these organs lie so embedded in the inflammatory effusion that nothing but a large mass can be felt. Commonly instances of this description are wrongly considered to represent great inflammatory enlargement of the prostate, whereas in reality, as a dissection will show, the prostate itself is not only not enlarged but as a rule somewhat diminished in size on account of the outside pressure. In chronic inflammation if there is no perivesicular involvement the seminal vesicle is apt to be distended and its walls somewhat thinned and hardened by sclerous fibrous change. Under such conditions there is a mucopurulent intravesicular secretion which may be abundant. In some of the cases granulations spring up over parts of the cavity of the sac occasionally giving rise to hemorrhage which may be extensive enough to fill the sac with blood clot.

A recent chronic perivesiculitis comprises a round cell and serous infiltration with here and there in every case little pus foci which may under aggravated condition coalesce forming abscess cavities which may act as has been described under acute condition.

As the surrounding inflammations become of long standing fibrous tissue takes the place of the round cell and the serous exudate are reabsorbed. In many instances of chronic seminal vesiculitis resolution has taken place in connection with the lining membrane of the sac the only lesion remaining being the perivesiculitis.

In operation on the seminal vesicle it is important that the operative approach be made in such a way that the diseased organ is well exposed before any trauma result. In view of the close anatomical and functional relation between seminal vesicle and prostate it is desirable to expose both organs and make them accessible for direct examination. The inaccessible location of the seminal vesicles between the soft parts of the small pelvis and the anatomical and technical difficulties of perineal operations make surgeon avoid these operations.

Several operations are described first operations from above (a) suprapubic (b) inguinal and (c) transvesicle second oper

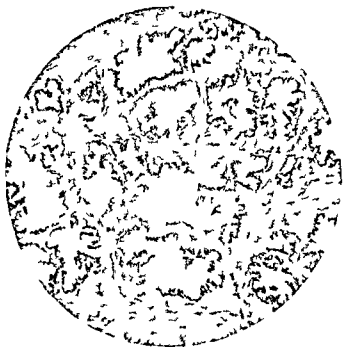


Fig. 8. Section of prostate removed at time of operation showing definite adenomatous change apparently secondary to chronic infection

ations from below (a) perineal and (b) ischio rectal

In operations from above the peritoneum must be pushed back from the bladder and the seminal vesicle must be found posterior to the bladder. In the operations from below the rectum must be separated from the bladder and the seminal vesicles located in the space between these two structures. The operation from above is dangerous on account of the fact that it is difficult to avoid trauma to the peritoneum. It is easy to separate the peritoneum from the bladder if the midline position is maintained but quite frequently the separation of the ducts causes difficulty and accidental rupture into the peritoneal cavity is fairly often reported. Another drawback to this operation is the unsatisfactory exposure which makes it difficult to recognize changes in the vesicles in the depth of the wound. Drainage is also unsatisfactory. The perineal operation is technically very difficult and there is danger of trauma to the rectum. The surgical wound heals well and the mortality is less than with the operation from above. A review of these operations for tuberculosis shows a mortality of 25 per cent with the method from above and 9 per cent with the method from below.



Fig. 9. Extreme dilatation of vesicles with extensive fibrosis of ampulla and both vasa. Reduced one fifth

The inguinal operation should be discarded entirely as impracticable. The transvesical operation is also undesirable unless it be combined with a prostatectomy and the need exists for draining the vesicles at the same time.

The operative approach through the ischio rectal fossa is used by several operators and is satisfactory. For the removal of tuberculous vesicles this route is particularly recommended. I described this in detail several years ago in *SURGERY, GYNECOLOGY AND OBSTETRICS* together with drawings showing the method used. The patient is laid on his abdomen and a longitudinal incision about 10 centimeters long is made parallel to the middle line on the side of coccyx and anus. This corresponds to the extent of the ischio rectal fossa. The fat of the ischio rectal fossa is removed and the levator ani muscle exposed. This is divided with an incision at least 5 to 6 centimeters long. Then the fascia which forms the sheath around the rectum and bladder is cut in a line corresponding to the longitudinal axis of the intestine at the border line between rectum on one side and the bladder or prostate on the other side. This point is marked by the veins of the vesicoprostatic plexus and the incision is made on the dorsal side of these vessels. Two fingers are introduced into the slit of the fascia and the rectum is lifted from the bladder. When this is pushed aside one seminal vesicle is brought into the wound and may be handled adequately.

The technique for perineal drainage of the vesicles was originally described by me some

5 year ago and in many ways a modification of procedures formerly used by others.

It is most important to use the position advised by Dr. Young and called by him the exaggerated lithotomy position. A flat board is most satisfactory for maintaining the patient in this posture. If this is not available however the patient should be brought well forward on the table shoulder clamps should be fixed in place and the scum elevated on a pad at least 5 inches thick. The buttocks are then pulled out over the edge of the table—this is most important in that it permits the carrying out of posterior retraction. The sound is inserted into the urethra and held in position by the assistant. The incision runs from a point superficial to the scrotal tuberosity and is carried in a curved line the center of which should correspond to the point at which the urethra leaves the bulb to enter the prostate. The incision is carried fully  $\frac{1}{2}$  inch deep in the center. The lateral folds are then dissected free by blunt dissection. At this point circular search should be made for the characteristic fibers of the central tendon. This I consider one of the most important features of all perineal surgery. Proper and accurate division of the tendinous structure releases all the perineal muscles prevents bleeding and greatly facilitates the procedure. As the tendon is divided the bulb retracts anteriorly the transverse perineal muscle is released and the apex of the prostate comes into view.

The sound may then be removed and a vesical tractor introduced. There are several types of these available. The prostate is elevated into the wound and dissection of the fibers of the recto urethral muscle begun. This muscle lies between the rectum and prostate and hugs the capsule of the latter. If dissection is begun at the apex close to the urethra and completely carried out until the capsule of the prostate is identified the danger of injury to the rectum will be avoided. It is possible to introduce a finger into the rectum as a guide but as it endangers sepsis it is not to be advised. By blunt dissection alternating with the division of the fibers with the scalpel the major portion of the muscle is removed and can be retracted. This brings

the body of the prostate into view and with the blade of the tractor or a sponge the entire surface of the prostate can be exposed.

The fibers of the levator ani muscle come into view at this time and some of the es seem to blend with the fibers of the recto urethralis. In general however the direction of the muscle is anterior and posterior. It can be lifted from the surface of the prostate with the index finger and at the same time the finger can be swept around until tissue to either side of the gland are free. At this point care should be taken to recognize the existence of several fascial plane constituting the capsule of Denonvilliers. With delicate dissection this capsule can be divided and one plane made out extending posterior to the anterior wall of the retrovesical space. After division of the first layer a second layer should be identified and stripped back to the same point. Two fingers should then be inserted into the space and the vesicle are felt stretched out to either side on the base of the bladder. Occasionally a thin layer surrounds them in this position and can be broken through with the tip of the finger. Enucleation is thus begun. The organs will stand a severe amount of traumatism and they rarely seldom ruptured in the process of enucleation. A gauze sponge on a holder is of assistance in the enucleation process and in drawing the entire group of retroprostatic tissue forward where the bladder separation of the vesicle can be completed under guidance of the eye. There is seldom any danger of injury to the vesicle themselves. Inflammatory changes usually take place in the neighborhood of the impulla and between the vesicle and the vesicle in this area. In the completion of the dissection the vesicle is easily ruptured and if this occurs it should be tied off. Vesiculotomy or vesiculectomy may then be done according to the special demand of the operation. Vesiculectomy seems quite effective provided all cavities are thoroughly destroyed. If there is much inflammatory change around the impulla an incision is usually noted a small incision should be made here and in addition the prostate may be liberally incised. Often times the prostate will be reduced to half the size following this incision.

Two gauze wicks are then inserted into the retrovesical space the vesicles replaced and two bits of rubber tubing inserted together with the drains. It is seldom necessary to tie a single vessel. This is particularly so if accurate dissection of the central tendon has been made. The tractor is removed the free edges of the levator ani muscle are brought together with a double suture of chromic catgut and the skin wound is closed with interrupted sutures. This technique differs mainly in the retraction of the levator ani muscle. In other procedures this muscle is cut and although more room is thus secured not so good an operative result is obtained. No serious complications may be looked for. Retention is relieved easily by catheterization and bleeding—which seldom occurs—may be controlled by packing. The gauze is removed on the second day and the rubber tubes held in place. These should be kept in position for 5 or 6 days and the cavity irrigated twice daily during this time. Patients are allowed up on the eighth or ninth day and the sutures removed as soon as possible. The edges of the wound usually heal firmly by the third or fourth day and the center of the incision is kept open for drainage purposes.

In my opinion it would seem that we are eventually coming to the point of view that suppurating complications of venereal infections will be considered from the surgical standpoint. This has already taken place as regards epididymitis and it is recognized that the possibility of sterility is much less likely if an epididymis is drained provided it does not quiet down after a reasonable time. So too with attacks of acute prostatitis prostatic abscess and seminal vesiculitis. Unfortunately the marked diversity of opinion as regards perineal prostatectomy influences perineal operations and perineal procedures. Then too the incidence of impotence and other functional disturbances following an operation are always attributed to the operative procedure itself. It does not seem to me that the incidence is greater in cases so operated upon than in cases not operated upon and a chronic inflammatory sclerotic change develops.

Operations on the third type of prostate described generally give unsatisfactory re-

sults. These cases are of the same type that was formerly operated upon for persistent discharge and the results have been identical. With this conception therefore when definite signs exist as to the presence of suppuration about the deep structures of the perineum and when a definite operative procedure obtains for the relief of this condition with no danger of mortality it would seem that the indications are clear cut as to the method of dealing with it adequately. Proper drainage should be provided and this can be obtained most satisfactorily through perineal incision.

#### CONCLUSIONS

1. Acute suppuration in and about the seminal vesicles and prostate which does not quickly respond to palliative measures should be given perineal drainage.

Many cases of ischiorectal perirectal and superior pelvirectal abscesses and urinary extravasation have their origin in a perivesicular cellulitis and in the common treatment of the condition the original focus is usually entirely disregarded. In this respect they are analogous to peripelvic infiltration secondary to chronic tubal suppuration in the female and are equally a source of chronic infection.

3. Prostatectomy and vesiculotomy are most effective in the treatment of acute and chronic joint conditions and should be practiced more freely. Operation usually gives immediate relief from pain prevents gross joint changes and induces hastened resolution of the inflammatory areas. Drainage should be maintained for at least 10 days and is of utmost importance in the after treatment.

4. Operation does not guard against recurrence in the rheumatic cases and sterility and functional disturbances are to be reckoned with. Sterility is probably co incident with the operation and not caused by it.

5. The periprostatic infection with infiltration of the ejaculatory ducts is largely contributory to the vesicular infection and free adequate drainage must be provided by liberal prostatic incisions.

6. In cases with remote or recent venereal etiology operation may be performed without undue risk and the mortality is nil.

## CHANGES IN THE CHLORIDE METABOLISM IN ABDOMINAL LESIONS<sup>1</sup>

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THE work of Brown, Easterman, Hartman, and Fowntree, Hudson and Orr, Dixon, McVicar, and others has emphasized the importance of changes in the chloride metabolism in obstructions in the gastrointestinal tract and in similar allied conditions. It is not generally recognized, however, how frequently such conditions may occur in the proper treatment, particularly by the administration of large doses of sodium chloride may often prove to be a life-saving measure. For this reason, therefore, we are reporting a series of cases all of which were observed in a relatively small hospital in less than a year's time.

Every surgeon is familiar with the patient with an abdominal lesion who comes into the hospital in an extremely toxic condition and who is recognized immediately as a surgical risk. An analysis of the symptoms presented by the patients show that they fall into two general groups: first, those due to the pathological lesion present in itself, and those due to the associated toxemia. The death of the patient may be due to either the toxemia or to the original lesion or to both. The point of differentiation is in my opinion one of proper medical treatment. The symptom due to the toxemia may frequently be relieved, thus preventing the death of the patient from this cause or at all events may make him a much better risk for operative procedure which will relieve the underlying pathological condition.

The symptoms of the toxemia for purposes of discussion may be grouped as follows:

### DEHYDRATION AND ITS CONSEQUENCES

Dehydration seems to be primarily due to the decreased fluid intake and to the increased vomiting frequently seen in such patients. In addition to the dry mucous, parched tongue and other general manifestations of dehydration we also are apt to find a high hemo-hol in due to concentration of the blood

and in oliguria. In the later stages albuminuria and red blood corpuscles may also be found in the urine.

### VOMITING

Vomiting is seen in many such patients and added to the severity of the toxemia due to the tremendous loss of water and chloride which may occur in the vomitus. A gastric dilatation is frequent and large quantities of fluid may be found in the stomach on aspiration even though actual vomiting is light or absent. Vomiting, however, is not essential for the production of this syndrome since low chloride figures in the blood have been observed both experimentally and clinically in the absence of vomiting. Functional vomiting may even be severe enough to produce the syndrome in the absence of any organic lesion.

### CIRCULATORY SYMPTOMS

The patients are commonly seen in a shock-like state with a weak, thready pulse and low blood pressure. The anemia is often pronounced. The patients may become drowsy or semicomatose or even delirious symptoms which are most probably due to circulatory disturbances in the brain. Such a condition is sometime difficult to distinguish from ordinary surgical shock and the presence of the changes in the blood to be described later often a very helpful point in the differentiation. In some cases a peculiar scarlet flush may be seen over the face apparently due to local vasodilatation.

### NEUROMUSCULAR IRRITABILITY AND TETANY

When the carbon dioxide combining power in the blood reaches the vicinity of 100 volumes per cent, general fine muscular twitchings and various tonic manifestations, even actual convulsions may be observed. The level of carbon dioxide at which tetany develops is only approximate rather than absolute.

TABLE I —UNTREATED CASES WITH LOW  
BLOOD CHLORIDE

N m l N m b	D t	B o o C m y			D g o s d m k
		Chl d 75 3 5 mg	CO 50-7 5-15 mg	N P N 5 35 mg	
		75	4	46	P f t t t t y p h l l l t h t t t t t t y p h l l l t h
	9 8	75	74	34	Ch d m l m t p t d n ed N m l d m t g D
3		8	76	36	Ch t f a l m p t t h t R
4	7	8	7	38	I d p t h u h a m h g p e t o t O p t y
5	8 3	7	6	33	A p p l t m y f t p p d t g s l t p p R e c t y d p m t
6		7	8	5	G t t t t m y f D d m h d t p t h k f f t t t
7	5	7		3	A d m t t d s t t t t k f h r d t h t p t R
8	3	65		43	S t O p t g u l t l g u l h r y
9	9 8	65	7	34	C h l y t t m y o s D d f b l h a m h g
		65	64	3	O p t d p f p p t e d g t t w t h p t s l g m t g f m R p t d p t g 4 R y
	5	65	64	4	R t u d y f t p t f c u t R y l b t
	9	63	63	36	V t l h t h t t t p y 9 8 P t y t t t p y
3	8 7	63	64	36	T a m f m b R y
4	3 7	64		34	A t t t k f h y h l t p e t t t t t t
5	3 3	6	53	3	B l y l t h m h m t g R y w t h t i
6	0-5	60		38	0-6 Ch l y t t m y s g t C f l w g p t w t h t m y R y
7	4	6	5	5	O p t d p f p t d p p e d d s
8	0-6	6		36	A t t t t f h l y t t R y w t h t p t
9	8 5	56	64	3	C a l t b l C b o p l y p h l P t d m t g i f d t t m

TABLE I —CONTINUED

N m l N m b	D t	B o o C m y			D g d m k
		Chl d 75 3 5 mg	CO 5 7 5 7 mg	N P N 5 35 mg	
	9	56	65	38	9 f l p t m y l l 9 9 p p t t t t D l
	4 7	56		49	Ch D h t m l h p t D h g d p e d
		55		60	C f t l j m t t D l 6 h t t t t t t
3	8 7	34		9	F t t l p l d l t g f t t h R y t l d l t
4	9 8	5	70	4	0 h t m y M h j t g h t R m t g l
5		5	6	3	B b b t h t u n e D l j 7
6	3	5		3	3 0 h m l g D e d 4 6 f b h f
7	9 7	5	46	57	B h l j p g D d
8	8 4	4	7	39	8 l j t y f t p t D l 8 4 l p t
9	8 4	4	83	9	8 m t g 8 7 r t d f t l d d t b l t t t
3	4 7		5	79	D l t g g P t r t g g D e d 4 7 T m u l
3	4	35	7	59	4 5 d y p t f p d p t t d g t l 4 6 D d
3		34		35	H t m y o f t e d g l h R
33	7 9	33	47	69	7 4 p p l t m l d d l g d t p t p p l l p t t t l t 7 D d
3	6	3		67	B b l l p o g R y
35	8		65	4	O l t e d 7 f t g l t l l m l h D d 8
36	7	00	94	5	F d y h t y f t t r t t p l m t g t h t d t l l y All s y m p t t t t t

## SUMMARY

N m l N m b	C b t h l d p 6 mg m		C b t h l d p 6 mg m	
	3 4		8 6	
N p t t D l h M t l y p				



lute The mechanism by which such an alkalo is produced tetany is still unknown As far as we know all cases which were formerly called gastric tetany fall into this group

#### CHEMICAL CHANGES IN THE BLOOD AND URINE

Three changes may occur in the blood (1) a fall in the chloride content (2) a rise in the carbon dioxide combining power thus producing an alkalo and (3) a rise in the non protein nitrogen of the blood Of these the fall in chloride content appears to be primary and may or may not be associated with the other changes described

It has not yet been accurately determined just what becomes of the chloride which disappears from the blood The vomitus will account for some of it but as we have mentioned above some patients do not vomit The chloride content of the urine is low so that it is not explained on the basis of an increased excretion

In a general way the rise in the carbon dioxide combining power parallels the fall in chloride but careful studies of the inorganic content of the blood in terms of milliequivalents have shown that the relation is not a constant one and that other factors must be operative

Occasionally acetone bodies may be found in the urine at the same time that the carbon dioxide combining power is high This may give the physician who is relying upon urinalysis the false impression that the patient is suffering from acidosis If this leads to the administration of sodium bicarbonate the condition of the patient will be made worse The reason for the presence of the acetone bodies is that there is insufficient glucose being oxidized by the body to permit the complete combustion of the fatty acid formed from the food and body fat and this condition is relieved by the administration of glucose

The rise in non protein nitrogen is due to two causes first an increase in the destruc-

tion of tissue protein which is also shown by an increase in the non protein nitrogen in the urine and later in the disease an actual toxic renal lesion which can also be demonstrated by a fall in the phthalein excretion

We have attempted to show the type of case in which this syndrome of toxæmia occurs by taking from our laboratory record all cases in which a low chloride was found in the blood and then finding in what clinical condition the figures occurred These cases are called untreated in the sense that the record of only one blood examination is available to us They are arranged in Table I in the order of their decreasing chloride content It will be noted that in patients in whom the blood chloride was between 60 and 275 milligrams per 100 cubic centimeters the mortality was not extremely high Apparently individuals with this mild degree of toxæmia are able to recover with ordinary method of treatment As the chloride content of the blood falls below 260 milligrams however the mortality becomes progressively higher and higher The difference in death rate is clearly shown in the summary at the end of the table It will be noted that the vast majority of these conditions is due to lesions within the abdomen

The physician often wishes to know in what type of case the patient and laboratory should be burdened with the time and expense of these blood tests We would suggest tentatively since the statement may be modified by further experience that such procedure is indicated in the presence of (1) partial or complete obstruction in the gastro intestinal tract (2) general peritonitis when any degree of general toxæmia is present (3) protracted vomiting from any cause (4) burns with much toxæmia (5) marked abdominal distention in medical cases (6) any other abdominal lesion showing the type of toxæmia previously described

To avoid an unnecessary amount of laboratory work in this group it should be remembered that the patients must be extremely sick and toxic before significant chemical changes occur in the blood Therefore it is unnecessary to resort to the laboratory when only a slight degree of vomiting dehydration and other symptoms are present The only excep-

Table I  
The following table shows the results of blood and urine examinations in 100 cases of toxæmia. The cases are arranged in order of decreasing blood chloride content. The first column shows the blood chloride content in milligrams per 100 cubic centimeters. The second column shows the blood non-protein nitrogen in milligrams per 100 cubic centimeters. The third column shows the blood carbon dioxide combining power in milliequivalents per 100 cubic centimeters. The fourth column shows the blood pH. The fifth column shows the urine pH. The sixth column shows the urine specific gravity. The seventh column shows the urine glucose. The eighth column shows the urine acetone. The ninth column shows the urine ketone. The tenth column shows the urine bilirubin. The eleventh column shows the urine urobilinogen. The twelfth column shows the urine urobilin. The thirteenth column shows the urine urobilinogen. The fourteenth column shows the urine urobilin. The fifteenth column shows the urine urobilinogen. The sixteenth column shows the urine urobilin. The seventeenth column shows the urine urobilinogen. The eighteenth column shows the urine urobilin. The nineteenth column shows the urine urobilinogen. The twentieth column shows the urine urobilin.

TABLE II—TREATED CASES WITH LOW BLOOD CHLORIDE

N m l N m b	D t	Bloo Ch MIST Y				D g s l d m k
		Chl d 75 35 mg	CO 5 7 /	N P N 5 35 mg		
	8 5	7	86 6	3 6		P t l t t l b t t f m dh A t 4 p l t g h t R ry w h t p t
	7	5 8	7 38	3 68		Int mutt t p l b t t f m p t l m'g Exp l t D d f m th d hock
3	4 5	6 95	54	58 57 5		St g u l t d R h t h w h p f f t d f to t B f p t m t 3 D d s
4	4 7 9	5 4 6	7 43 68	57 46 34		R p t e d p p d G l P t t t t d t m t D g h l t t m t D g h l t t m t D g h l d t m t S d y t l b t t R l f l d l b d Chl d t m y R y
5	5 8	4 3	8 66	46 3		V t o s t m y f l l g g t o A f t p l B f t t m t m t A f t t m t
6	8 8 8 8 9	9 4 8 3 5 6	4 7 56 5 70 7	63 3 3 9 4		R p t d p p d w h d f f p t t l O p t d d 8 Post p t l b f t t m t Chl d t m t Chl d t o s t m y f l Chl d t m t R y
7	8 6 8-7	8 8	66	3		G e r p p d t l l P t t B f p t A f t t m t R ry
8	4 4 4 4 4	3 4 46 6 5	49 4 4 54 4	4 7 7 4		R p t d p p d t h g l F p d y t f g l d Chl d t m t t f f Chl d t m t t f f Chl d t m t t f f 4 7 d g p l b S d d
9	8 9 9 9-7	7 3 15 8 93	78 64	86 55 3		P t l t t l b t t f m dh B f t m t A f t b g g f t m t A f t p t R e d f m C b t t t b t d d f m p m
	8 8 8 8	3 56 67	6 68 73	44 34 4		C m p l t b t r u t b y t h O p t e d 8 b f t m t A f t t m t C l t R ry

TABLE II—CONTINUED

N m l N m b	D t	Bloo Ch M			D g n d m k
		Chl d 75 35 mg	CO 5-7	N P N 5 35 mg	
	7 7 7 7	5 6 36 4	5 66 86	6 55 7 05	Ep d m p h l t th g p l y d l T t m t w h l l beg D d f m p h l t 7 3
	3 4 4	9 3	7 58	39 9	Ch l c y t t m y Post p t g t t R ry f t t m t
3	3 4	7 75	55 65	5 4	P t t t m y m t g l T p t R g l r y f t t m t
4	7 8 9		94 8 96	3 7 4	N a d t m u g f p c y A d m t d A t 4 p l T t l l y t m b l t A l k l d t d A t t l l y A t p l A t p l N t R y
5	3 6 7 9		8 66 66	8 3 34	G h t l f f b d m t h t t l p f t L p t m y d t Chl d t m t
	3 4 5	3 8 3	6 76 6	35	D g f t p t l b R e l t f h t d t D d t h g h
6	3 3 3 3 3 3 3		58 5 51 57	44 54 51 7	P d m g Post p t t leu Chl d t m t t t l Toxæm d 3 4 f b h s d m p y m

tion to this rule is in patients to whom sodium bicarbonate has been administered when an extremely high carbon dioxide combining power may be found in individuals who are ambulant and complaining of only the very mildest symptoms such as headache anorexia malaise etc

The aims of treatment in such patients are twofold The medical management attempts to relieve the toxæmia The indication for surgical treatment is to remove the primary condition The closest co operation between physician and surgeon is essential at all times if the life of the patient is to be saved

The treatment for the toxæmia consists of four measures vigorously and consistently carried out

1 The administration of water by all possible route and in practically unlimited quantities unless there are other contraindication. The measure is designed to relieve the dehydration to counteract the factor of shock to promote diuresis and thus to aid excretion of water and nitrogen by the kidney. Only when the result have been achieved can the patient be said to have had sufficient fluid.

2 The administration of glucose. The nitrogen metabolism in a fasting patient is high due to the fact that he is burning large quantities of protein from his own tissue. Ingestion of even moderate quantities of glucose spare the nitrogen metabolism considerably. By the use of protein sparing food the protein metabolism may be reduced to at least a third of the fasting metabolism. This is of particular importance in case we have been above the protein metabolism much in excess in the condition. Concentrated glucose solution intravenously also have a very marked diuretic action which is valuable in condition associated with hypoxia. Because of the frequent reaction to mixing with the lean it is only occasionally that enough glucose can be administered by mouth. Ten per cent glucose intravenously at least twice a day is commonly used but this can be readily increased to 50 per cent without danger. It is safest in all intravenous work not to give more than a total volume of 100 cubic centimeter at one time. One thousand cubic centimeter can be given however if the injection is made at a very slow rate. Glucose can also be given by rectum in concentration up to 5 per cent although the absorption is variable.

3 The administration of sodium chloride. Many surgeons state that they use sodium chloride in the treatment of all cases of intestinal obstruction but close inquiry usually discloses the fact that they are referring to normal (0.9 per cent) sodium chloride solution. The dose necessary for the proper treatment of such cases are relatively enormous. Haden and Orr suggest that 1 gram per kilo of sodium chloride be given as an initial dose in acute intestinal obstruction and then the subsequent dose regulated by the chloride content of the blood. They report that in one patient 30 grams of sodium chloride was given

during the first 36 hours after admission. Only 18 grams of this appeared in the urine and the blood chlorides did not rise above normal showing that the body tissues needed and utilized this enormous supply. To give the patient this much sodium chloride as isotonic saline would have required the absorption of 10 liters in 36 hours subcutaneously and by rectum. Subcutaneous and rectal infusion should not be neglected but in addition it is necessary to use other route. For mild cases of toxemia the intravenous injection of 1 to 5 per cent sodium chloride and glucose can be used. In the severer case 10 per cent sodium chloride is necessary. If an enterotomy has been performed sodium chloride can be placed directly in the bowel.

The only guide to the adequacy of the chloride is the content of the blood in chloride. In the case of toxic patients this should be determined daily. If the figure for chloride is below normal it indicates that insufficient chloride has been administered during the preceding 4 hours.

The administration of chloride also causes a fall in the carbon dioxide combining power of the blood and the additional administration of hydrochloric acid or calcium or ammonium chloride does not appear to be necessary. In the case of tetany due to alkalosis this might be considered as an emergency measure however. The combination of glucose and water in dilute also cause a restoration of non protein nitrogen to normal level.

4 Gastric lavage. Large quantities of fluid often accumulate in the stomach of such patient and this as well as the tendency to vomiting is often greatly improved by frequent gastric lavage if there is no contraindication from the surgical standpoint. This probably act by tending to restore muscular tone in the gastrointestinal tract which is notoriously defective in such patients and will tend to relieve any tendency to gastroenteric shock if the latter be present.

The result of this form of treatment are shown in Table II as well as the results in some cases which were inadequately treated. Brief summaries of the 6 patients are given below. It will be noted that the chloride in these patients in most cases are well below 260

milligrams and hence are in the group which Table I shows to have a high mortality.

In observing these patients clinically the correlation between the relief from the toxemia and rise in blood chlorides is striking and one gains the impression that the blood chloride test forms a very reliable guide to the progress of the toxemia. It must not be forgotten however that many of the symptoms may be caused by the abdominal condition or by other factors rather than by the toxemia. It is difficult to describe on paper the striking clinical change which sometimes occurs in these patients after treatment has been begun.

#### CASE REPORTS (TABLE II)

**CASE 1.** A nurse entered the hospital with a partial intestinal obstruction probably due to old postoperative adhesions. The urine showed large quantities of acetone throughout her entire stay in the hospital but in spite of this the findings in the blood were those of toxemia with alkalosis. She recovered under medical management without operation and a repetition of the blood chemistry showed that the figure had returned to normal.

**CASE 2.** An elderly male entered the hospital with a history of intermittent pyloric obstruction and an abdominal mass. The chemical studies showed moderate signs of toxemia. The patient's condition improved under gastric lavage. An exploratory operation revealed a retroperitoneal malignancy which was left undisturbed. On the day following the operation he went into a shock-like state from which he eventually died. The question arises as to whether the condition was one of shock due to recurrence of his gastrointestinal toxemia or simple postoperative surgical shock. Chemical studies showed that the latter was the case.

**CASE 3.** A white male aged 55 was admitted to the University Hospital January 23, 1917, after an illness of 4 days duration. At operation a strangulated Richter's hernia was found on the left side. A portion of the gut which had become invaginated in the internal ring was perforated and a localized peritonitis had developed. The patient was in very bad condition. An enterotomy was performed and the abdomen drained. Previous to the operation he had been given 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose solution and also 800 cubic centimeters of isotonic sodium chloride solution subcutaneously. Following the operation he was given 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose twice daily during the first day and once the second day. The patient died the second day after operation. Except for the retention of non-protein nitrogen probably indicating renal failure the blood at the time of his death was normal.

**CASE 4.** A white male aged 3 was admitted to the University Hospital January 4, 1917, after an illness of 3 days duration which was diagnosed as ruptured appendix with peritonitis. At operation the appendix was found to be gangrenous and a general peritonitis had developed. The appendix was removed and three drains were inserted. Isotonic sodium chloride solution had been administered both by rectum and by subcutaneous injection as soon as the patient entered the hospital. Two days following the operation the patient developed a paralytic ileus with obstruction vomiting a large quantity of fecal material. Five hundred cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given intravenously twice a day, the stomach was lavaged and a duodenal tube left in place. Enemas were given but were only slightly effective. The blood picture returned to normal under this treatment and the toxemia subsided.

On January 11 the patient became completely obstructed. A second operation was done and a complete obstruction of the small bowel was found. The obstruction was produced by the matting together of the small intestine by adhesions. The obstruction was released and an enterostomy was performed. This secondary obstruction was accompanied by a recurrence of toxemia and a fall of the chlorides in the blood. The patient returned to the ward in very bad condition. Intravenous medication was again administered twice a day and the stomach was lavaged at intervals. Very profuse drainage was obtained through the enterostomy opening. This treatment was continued for nearly 4 days following the second operation and from this time on he made a very satisfactory recovery. The patient was discharged from the hospital on February 7 in satisfactory condition although there was still a slight discharge from the enterostomy opening.

**CASE 5.** A white male aged 37 was admitted to the University Hospital on October 5, 1916, with a diagnosis of chronic duodenal ulcer with partial obstruction of the pylorus. The patient had been operated upon 3 years ago for perforated duodenal ulcer and had been well until several months previously when he began to have recurrence of his dyspepsia. A posterior gastroenterostomy was done on October 6 for a large infiltrated ulcer which almost completely obstructed the pylorus. Six days following the operation he began to vomit large quantities of greenish material. At this time it was thought that possibly an obstruction had taken place in the area of the distal loop but later it was decided that a vicious circle had developed. Intravenous medication was begun 500 cubic centimeters of 5 and 10 per cent glucose with salt being given twice a day for 3 days. The patient was allowed only small amounts of water by mouth. The duodenal tube was passed at different intervals. After the third day of intravenous medication the patient seemed to be in much better condition. During the entire course of the treatment the patient's skin was moist and his output was good. From this time he made

## ZINC-CALAMINE DRESSING IN THE IRIATMENT AND ATTIRE- TREATMENT OF FRACTURES

By DR. ERITZ SCHNEK

A. T. B. H. L. C. F. B. A. A. I. T. O. J.

Of all medical problems the treatment of fracture is the one most frequently concerned with mechanical method and for this reason the mechanical viewpoint of fracture treatment is apt to be overemphasized. Treatment however demands not only considerable knowledge of all types of splints and bandages, but also anatomical training and a complete understanding of the complicated mechanical conditions present. But all these things are of little avail unless the very best dressing is available. If it is immediately applied either because of the ease of the technique or because of the general use. There is a vast difference between bandaging in a hospital where all the modern facilities are at hand and bandaging under emergency conditions without the aid of trained assistants and the best equipment. Considerable dexterity is necessary in order to apply quickly and with the necessary care. An ill-fitting dressing does not only fail to protect and thereby annoy the patient unnecessarily, but it may even prove a hindrance to the necessary care. However, experience has taught that it is almost never a failure to use the zinc oxide dressing, hence one must make every effort to have the initial treatment as perfect as possible.

It must be remembered in the use of a new method for the first time that no matter how accurate and detailed the description of the technique may be, one cannot overcome the handicap of unfamiliarity with a technique but repeated practice. One who is employing a technique for the first time can possibly have the dexterity of the experienced physician who has all the details at his fingertips. Furthermore small mistakes during the initial attempt to follow a new technique may not only lead to failure in that instance, but may also lead to the abandonment of a really valuable method.

Because of the fact that a number of courses given at the Vienna Accident Hospital for the American Medical Association have shown that the advantages of the zinc gelatin dressing in the treatment of fractures are unknown to many American physicians. I wish to describe here the use for and the technique of this dressing.

The zinc gelatin dressing is a semi-elastic dressing consisting of 4 layers of a loosely

woven cotton bandage the meshes of which are filled in by the thick fluid of zinc gelatin. This dressing was first introduced by Unna for the treatment of lacerations and it proved very valuable in such cases as it not only does not irritate the skin but may cure open ulcers and eczemas. Furthermore, as the bandage also sticks well to the skin and prevents the occurrence of edema, the dressing is even more practical for the treatment of fractures than is irritating cast plaster. The constitution of zinc gelatin is as follows:

Zinc oxide puriss.	100.0
Calamine	100.0
Aqua fontana	500.0
Glycerin	400.0

It is advisable to use only the very best materials in the preparation of the mixture since otherwise the glue is not absolutely reliable.

### PREPARATION OF THE MIXTURE

The zinc oxide is mixed with just enough water to make a thick paste. After this paste has been well mixed and stirred, it is mixed with the glycerin. The gelatin which has been softened in cold water must be freed of as much water as possible by squeezing well with both hands. The gelatin then contains just 3 parts of water to one more water need be added. It is then put on the water bath and stirred constantly. It becomes fluid in 5 or 10 minutes. When the zinc oxide-glycerin mixture is added and after a few minutes stirring the glue is ready for use. It is advisable to prepare a large quantity at one time, pour it into a shallow dish and cut the elastic mass into smaller pieces. Then whenever some of the mixture is needed a few pieces are put on the water bath and warmed up with stirring until they become fluid and are ready for use. It is not necessary to add a disinfectant or preservative.

Organdie bandages 10 and 15 centimeters in width should be used. This material because of its broader meshes allows the thick glue much more readily than ordinary bandage material. A 10 centimeter broad flat hair (not bristle) brush is used to print the mixture on the skin and bandage. In order to keep the zinc gelatin fluid during the process of printing it on the bandage the pot of glue should be kept in a



Fig. 1 Brush zinc gelatin cut in pieces broad and narrow bandages

pan of hot water. Two pounds of zinc gelatin are sufficient for 5 dressings of the lower leg

#### GENERAL TECHNIQUE

A few pieces of zinc gelatin are put on the water bath to warm. As soon as the glue is fluid it is brushed over the *unshaven* skin and the bandage laid on in spirals under slight tension. The edges of the bandage must not cut into the skin since disturbances of circulation would thus arise. For the same reason, no folds are made in the bandage. Instead the bandage is cut when ever it does not fit well and is begun anew from that point. After the first layer of bandage has been put on a new layer of glue is brushed on and then another layer of bandage is put on in precisely the same manner as the first until 3 layers of bandage and 4 layers of glue have been put on.

The last layer of zinc gelatin will dry in 20 minutes and after that it will not soil clothing or linen. If one is in a hurry the last layer of glue can be covered with a layer of cellulose or treated with a solution of 6 parts of formalin in 94 parts of alcohol. The dressing remains on for 2 or 4 weeks until it has either become soiled or loose. It can then be replaced by a fresh dressing if necessary. The bandage is removed by cutting it up the anterior side and then jerking it off suddenly so that the pain due to the pulling out of hairs is reduced to a minimum. In patients who perspire freely the bandage soon becomes loosened. In order to keep it tight it can be treated with the solution of formalin in alcohol.

#### AN EXTENSION DRESSING IN FEMORAL FRACTURES

The general treatment of fractures of the femur cannot be considered here. Succinctly such fractures are treated by extension dressing on a Braun splint. The extension is made directly on the bone by means of a Steinmann peg which is driven through the tuberosity of the tibia. This peg is removed in about 3 weeks and replaced by a zinc gelatin extension dressing.

The following technique is used. The glue is brushed on the thighs the hips and circularly



Fig. 2 a Calico bandage b Gauze bandage c Organ di bandage

around the abdomen and then a layer of organdie bandage is laid on. A second layer of glue is put on next and is followed by a layer of calico bandage 10 centimeters wide which is put only on the lateral sides of the thighs from the inguinal region to the middle of the femur. Glue is spread on top of this. The ends of the longitudinal calico strips are turned in to prevent later slipping and are fastened by circular layer of bandage. The dressing is finished in the usual way with the bandage forming a regulation spica in a thigh to belly direction. The longitudinal strips of calico should not be fixated except above the femoral condyles as they would otherwise cause disturbing pressure upon the latter. The dressing is allowed to dry for 1 day while the extension weight is still acting upon the Steinmann peg. The following day the two longitudinal strips are connected by a V shaped wire stirrup and the weight transferred from the peg to the thigh.

After the peg has been removed the lower leg and the knee are covered with zinc gelatin. A layer of bandage is placed over that then as on the previous day a medial and a lateral longitudinal layer of calico is laid from the knee down to about 30 centimeters beyond the sole of the foot. Then the dressing is finished just as on the thigh, totaling 4 layers of zinc gelatin and 3 layers of bandage. The ends of the thigh bandage and the dressing of the lower leg must cover each other very well as otherwise a disturbing so called interstitial oedema would occur. The soft parts at such a point are oedematous and protrude from between the bandages so that ulcers may occur at the penetrating edges. The 2 longitudinal strips on the lower leg must not be fixated down to the malleoli but must be free of the skin from there down as ankle pain would otherwise occur. The dressing is completed as follows: the ankle and the foot are painted with glue. Then a strip of calico is stretched from the heel over the sole of the foot to about 30 centimeters beyond the toes and a similar strip from the joint of the foot over the dorsal side to the same distance beyond the toes. The usual alternate layers of zinc gelatin and



Fig. 12. a b c d e  
 l g s Bru h g th g l t n ul ly d th  
 kl j t l kl l B d g l l u l th  
 kl j t d kl Bu h g l t th k  
 f th l l g d W l l tl la d g th l l g  
 Th f l l g l t d g c mpo d f 4 l y  
 f h l t l 3 l y fl l g

bandage are put on. The anterior strip serves to keep the leg from rotating and the foot from moving into a pes equinovarus position. It is also necessary in this case to see that the ends of the second bandage and the last one overlap so that oedema will not occur. The bandage reaches as far as the basal phalanges of the toes the latter being kept free. The knee joint and the ankle joint must be slightly flexed during the dressing so that the bandage will not cut and cause pain later on when movements are begun.

The day after the entire dressing has been completed that is if the parts over the lower leg and the foot have dried sufficiently the traction strips on the lower leg and the foot are also replaced by a V shaped wire stirrup as above connecting the 2 parts of the bandage the extension weights are then equally divided between the upper and the lower leg. The traction on the foot passes by means of pulley over the bed and thus hold the foot in slight dorsal flexion. In this way active and passive movements can be started even with constant extension on the fragments and without the displacement of these fragments and resulting pain.

If however the patient begins to complain of pain this indicates that the dressing has been put on too tightly at that point and must be cut open with scissors. If any vesicle are found they should either be left alone or opened with a sterile instrument and covered with sterile gauze. Under any circumstances the patient must be carefully watched for the first 48 hours to see whether or not the toes keep warm and arterialized and whether or not they can be moved. If any unfavorable signs appear the whole dressing must be carefully looked over since either a paralysis of the peroneus nerve at the head of the fibula or an initial circulatory disturbance may result from a tight fitting bandage. In either event it is best

to cut the dressing up the front and renew it after a few days.

Zinc gelatin dressing will not irritate the skin even after months of use and should remain in place until it becomes loose. Depending upon the extent of movement and exercise and upon the degree of consequent muscular atrophy this will occur in 3 to 6 weeks. Then a new dressing is put on precisely the same manner as before the first lay only the thigh and hip part is replaced with the extension acting on the lower leg and the following day the weights are transferred to the femur so that the lower leg and the foot can be dressed.

In order that the joints may be used it is sufficient to take off the weight on the pedal extension and transfer the weights from the lower leg to the upper leg. The hip joint can be exercised by the patient sitting up in bed and then lying down again. In this way all the joints can be exercised with the fragments constantly in line and fixed.

The zinc gelatin dressing may also be very practical in the bloodless and painless *reposition of medial fractures of the neck of the femur* as Boehler has demonstrated.

In such a case the technique is as follows. The patient is immediately bandaged just as in the case of femoral fractures excepting for the fact that extension is dispensed with and at one sitting the dressing is completed with all its extension strips and no pelvic part. After a few hours the knee joint is stretched and the patient fixated to the lower end of the bed in abduction position by means of the strip on the lower leg the lower end of the bed is then raised about 60 centimeters higher than the head of the bed. The patient thus hangs entirely by his injured ex-

Lo Boehl E Bh dl g d m d al  
 Sch k l f l b b e h A g f U h k d B k Am d m 95

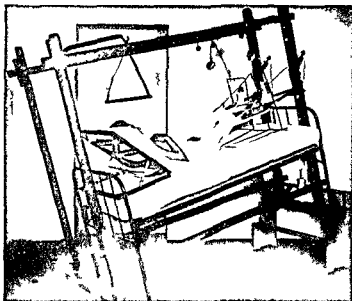
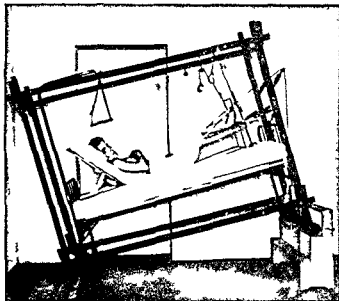


Fig 4 a and b Bilateral fracture of the femur complete zinc gelatin extension dressing, on the left on the right only

the femur part of the dressing is finished and the Steinmann pin is on the lower leg

remity. Simultaneously the tendency of the leg toward medial rotation is enhanced by a suitable form of lateral traction. Twenty-four hours later the ends of the fragments are in good position. This can be corroborated by X-ray and Shoe maker's line.<sup>1</sup>

As soon as the satisfactory position of the fragments has been determined the case is treated as a typical fracture of the femur: the leg is put on a Braun rack and the weights equally placed on the strips of the upper and lower leg. The advantage of this method is that no narcosis is necessary, particularly in old persons—and most of these cases are among the aged thus precluding the danger of pneumonia.

In *pelvic fractures* the zinc gelatin stretching type of bandage makes it possible to preclude the pain resulting from the movements of the extremities. For this purpose the dressing is put on so that it reaches from the inguinal region to the basal phalanges of the toes with the knee stretched. The only extension strip attached is on the lower leg and this passes over the pulley at the lower end of the bed and is loaded with 6 pounds. This slight extension is decidedly pleasing to the patient since superfluous movements of the leg are avoided and the pain resulting from necessary movements disappears.

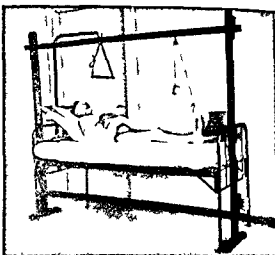
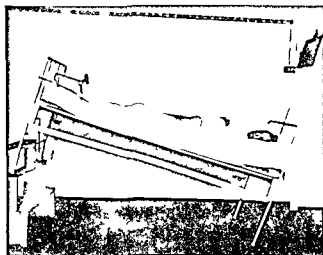
The zinc gelatin dressing plays an important role in the *after treatment* of fractures of the entire lower extremity. The first attempts at walking

after any bone injury to the leg or foot provoke a livid discoloration and swelling caused primarily by a disturbance of the circulation. The very best treatment of a fracture cannot enable the leg to stand up under normal usage; the result is a muscular atrophy which in turn leads to faulty circulation in the extremity and produces edema which damages circulation and nutrition. The edema in turn causes an atrophy of the bone and this naturally weakens the carrying capacity of the leg. This is in short a vicious circle which depends for revision upon a well functioning circulation. We are able to avoid all of these complications if we are in a position to restore normal circulation. A means to this end is found in the zinc gelatin dressing which possesses many advantages over other dressings. This bandage remains in place for some time without loosening whereas the usual bandage material soon becomes loose and must be changed frequently. This dressing does not prevent perspiration as does an elastic stocking or other dressings and therefore prevents ulceration due to secretions. Zinc gelatin dressing enhances the epithelialization and healing of any ulcers present under its protective covering since such a process is also dependent upon good circulation and tissue nutrition. The precluding of edema permits the patient to walk. In other words we afford the patient the best possible conditions for healing simply by means of this dressing and without any further after treatment.

The type of dressing used for after treatment reaches from the popliteal space to the basal

Shank  
p. b. l. w. th  
t. o. ch. t. w. th. t.  
d. p. ject. l. g. h. l. y. b. th. t. l. l. h. l. y. d. v. i. d. e. d. l.  
d. t. d. a. s. f. t. h. b. p. j. t.





1 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

1 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

phalanges of the toes. The technique is as follows:

The patient sits on a table with the lower legs hanging over the edge. Since the feet should be in slight dorsiflexion when the bandage is put on in order to keep the dressing from cutting in the ankle joint later it is well for the patient's feet to rest on the foot rest kneeling the procedure so that the skin may be stretched. The foot rest lengthens the knee with the region of the fifth metatarsal line in relation to the ankle joint. Pronation of the feet is very important for the preservation of the arch. A metal plate is used in the preparation of the cast in the case of the patient who has a flat foot will be given later.

As soon as the patient is in the knee and the foot has been fixed the zinc gelatin is brushed on the unshaven skin around the ankle joint and heel a breadth of about one centimeter. A double layer of bandage is made over this then more glue then another double layer of bandage. Then the entire lower leg is brushed with glue from the tuberosity of the tibia down to the bandage elastic on spirals under slight traction. If the spirals do not fit the leg is fastened in the bandage. Instead the bandage is cut with scissors—not torn—and wound on if fresh. The winding must overlap so that the skin is left uncovered. As soon as the calf and shin have been covered with a layer of bandage the zinc gelatin is brushed over the bandage which already is in place on the ankle joint and heel as far down as the basal phalanges of the toes and the dressing continued. As soon as the first layer of bandage has been laid on the

zinc gelatin is brushed on and the dressing repeated. As in the case of the dressing for the thigh 4 layers of glue and 3 of bandage are sufficient here the 4 layers are augmented in the region of the ankle by the double layers of bandage put on at first this is necessary since the greatest part of the body weight rests upon this part and the bandage needs greater strength at this point. The last layer of zinc gelatin is either covered with cellulose or hardened with the formalin alcohol solution. The entire bandage must be thicker than a heavy stocking so that in the case of an out-patient a shoe can be put on over the bandage.

The dressing leaves the toes completely untouched and reaches to just under the tuberosity of the tibia on the shin side and up to the popliteal fossa on the posterior side so that freedom of movement at the knee is possible. If the bandage is made shorter on one side or another then the vicinity becomes edematous and the edge of bandage cut into the skin and provoke vesicle formation.

In patients who perspire freely the dressing is rubbed down daily with the formalin alcohol mixture. Since the dressing does not irritate the skin it may remain in place from 2 to 4 weeks. Usually however patients with a marked pruritus will come back in a few days with the dressing loose. This is simply a sign that the edema has diminished and a fresh dressing is needed. For this reason the zinc gelatin dressing should be applied immediately after the removal of a plaster of Paris cast before any swelling appears. In case with particularly marked swelling the dressing should be put on with the leg

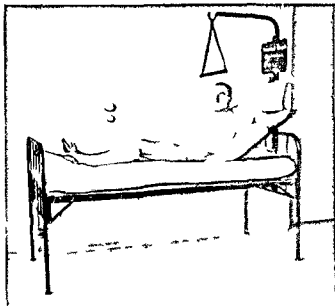


Fig. 7 Zinc gelatin dressing for the lower leg for the purpose of stretching the knee joint

raised or in the morning after a night's rest has produced a decrease in the swelling of the extremity. The time between bandagings should be as short as possible in order to preclude the possibility of any fresh oedema. The dressing is changed as frequently as is demanded by the presence of oedema, but the patient is neither kept in bed nor from his work.

The uses mentioned do not include all to which zinc gelatin bandage may be put. I also wish to describe a method which combined with extension treatment can be used to advantage for the *painless stretching of flexion contractures of the knee* as in arthritis deformans, distal femoral fractures, injuries to the knee, etc.

The zinc gelatin is laid on from the popliteal space to the basal phalanges of the toes and a medial and lateral strip of calico is glued in longitudinally and fixated as far down as the malleoli just as in the case of the dressing for the femur. This traction strip on the lower leg is passed over a pulley at the foot of the bed and weighted with 4 to 6 pounds. This equal and constant traction soon straightens the knee joint.

Zinc gelatin dressing is used in *contusions and sprains of the ankle and the foot* which are too slight for a fixation bandage and yet cause trouble when the patient walks. In such cases the zinc gelatin bandage has also displaced the ordinary bandages and elastic bands. It is always surprising to find how quickly the patients are freed from pain as soon as the dressing is put on. This dressing is particularly valuable in the treatment of athletic injuries since it permits a rapid return of move-

ment. It is especially remarkable that the feeling of insecurity in such cases soon disappears.

The especial province of zinc gelatin dressing however is that great class of diseases and complaints in outpatients resulting from *pathologically changed posture*. From cases of weak feet to the most severe forms of contracted flat foot from the shin bone fractures which have healed with a slight varal deviation to severe compound fractures of the calcaneus there is a chain of complaints which arise from the same cause, abnormal static conditions as a result of unphysiological functioning of the joints.

There is no doubt that a certain congenital weakness of the connective tissue apparatus plays a definite role in flat foot. This is also the reason why such patients also frequently disclose the varicose syndrome, muscular weakness and later obesity—all depending more or less upon the same constitutional anomaly. These conditions also have their bad effects on flat foot. In the later stages the incongruity of the articular surfaces leads to an arthritis deformans just as in traumatic complete flat foot this causes pain and keeps the patient from walking. This in turn causes atrophy of the already weak muscles because of inactivity and lack of body exercise and leads to further increase in weight which has the same unfavorable effect upon circulation that the reduction in functional usage has and promotes the incidence of varicose veins and ulcers. The patient is then forced to stay in bed and thereby loses the last vestige of muscular activity.

This vicious circle can be broken only by the restoration of movement in the extremity. To this end a well made and individually fitted arch supporter is necessary so that the movement in the joints of the foot may be rectified; such a method could be aided if necessary by a corrective operation. A second point is the restoration of good circulation. A zinc gelatin dressing not only helps the ligaments to function well but also helps to heal any leg sores, prevents the incidence of oedema and makes it possible for the patient to walk. Exercise strengthens the patient's muscles, avoids too great an increase in weight and promotes good circulation. This dressing causes an immediate improvement of the disability which is reflected in the improved walking ability. The method of dressing is the same as that for the lower leg. The dressing remains in place as long as it is not loose and is changed as often as there is oedema. This condition often lasts for months but is not harmful since the dressing does not irritate the skin and the patient can keep at work.

## THE MOST COMMON METHODS OF GASTROSTOMY WITH THE REPORT OF A MODIFIED TECHNIQUE OF THE JANEWAY METHOD

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**T**HE term gastrostomy (gastro stomie from *γαστήρ* stomach and *μα* mouth) was coined by Sedillot in 1846 to designate the operation for creating a permanent gastric fistula for feeding purposes. The Greek word *γαστήρ* also means abdomen and with this meaning the term gastrotomy had been in use for many years to designate any operation in which the abdominal cavity was opened. This inclusive use of the term gastrotomy continued throughout the greater part of the 19th century, occasionally being misspelled gastrotomy, resulting in a confusion of terminology which renders a search of the literature often both misleading and unproductive.

The establishment of a permanent gastric fistula as a means of alimentation in œsophageal stricture was first proposed by Egeberg (b) of Christiania in 1837. He conceived the procedure after having witnessed the death of a young man from starvation and thirst as the result of œsophageal diverticulum and stricture. Dilatation of œsophageal strictures by sunbaths and bougies was an accepted method of treatment at the time but in this case had failed. One cannot but be impressed by Egeberg's clear conception of the soundness and utility of an operation which he was for the first time proposing. He even suggested the employment and emphasized the safety of retrograde bouginage through the fistula for dilatation of the stricture as an added indication for the operation but he never put into practice what he was first to conceive.

In 1842 Watson (5) an American surgeon independently advocated the procedure in intractable œsophageal stricture and contended that it seemed rational and feasible.

In 1846 Sedillot (5) of Strasbourg, who was at the time unfamiliar with the earlier observations of Egeberg and Watson, began the publication of a series of articles on the nature of œsophageal strictures, advocating a rational procedure in their treatment, the operation for which he coined the term *gastro stomie*. His proposal was received with considerable disfavor. Gendron (11) in the same year denounced the proposed operation as a preposterous foolhardy and unjustified contention that the passage of sounds and bougies was a much more rational method of treat-

ment and was perfectly satisfactory. In spite of the classic observations of Beaumont (published in 1833) which were already quite well known, others questioned whether food taken in such an unnatural way could be digested and assimilated. All those who advocated gastrostomy based their contentions of the soundness and practicability of the establishment of permanent gastric fistula on the following well known facts: that persistent gastric fistula often followed wounds of the stomach (especially in war) and that they sometime persisted for years and were compatible with good health. Surely their propositions were sound. They had witnessed accidentally acquired fistulae of the stomach which persisted without fatal results. Why not construct one and utilize it as an avenue of alimentation when the normal one no longer served. Billroth (3) in 1841 first performed gastrostomy on dogs and was successful in several cases, using the animals for study of the physiology of digestion.

In 1849 Sedillot (7) first performed the operation on man in a case of carcinoma of the œsophagus, death occurring 1 hour after operation. He made a crucial incision just below the xyphoid, grasped the stomach, incised it and inserted a specially devised silver cannula with which he proposed to hold the stomach in contact with the parietes. The stomach being under great tension pulled the cannula inside the abdominal cavity, where it persisted in remaining. Feeding attempts were unsuccessful and some of the ingesta were found free in the abdominal cavity at autopsy. Sedillot (26) again attempted the procedure in 1853, attaching the stomach to the parietes with suture. Five days later the stomach was opened with a bistoury, a tube inserted and feeding begun. Death occurred on the tenth day. He made no further attempt. Fenger (9) in 1854, through an incision (which bears his name) along the left subcostal margin, attached the stomach to the margins of the tegumental wound, opened the viscus and sutured the mucosa to the skin. This suture of the mucosa to the skin is the chief feature in Terrier's operation done some years later. Death in Fenger's case occurred 58 hours. The first attempt in America was made by Maury (21) in 1869, also with a fatal termination.

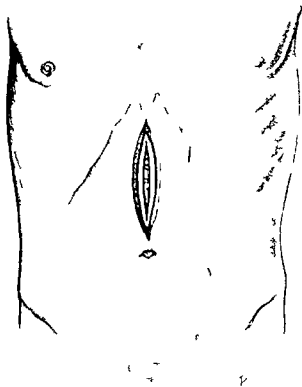


Fig. 1 The relative positions of the midline incision and the stabwound

In 1875 Sydney Jones (17) obtained the first recovery after gastrostomy. This was the twenty-ninth attempt in 26 years following its inception and the third of Sydney Jones. The patient lived

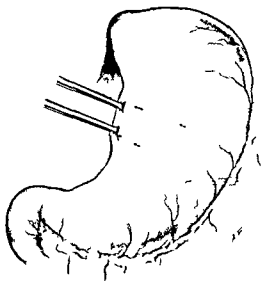


Fig. 2 The All clamps placed to outline the flap. The base of the flap is indicated by the dotted lines as their use is optional

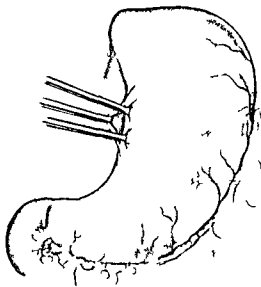


Fig. 3 The first incision for the raising of the flap has been made. A clamp has been placed at the center of the incision in the lesser curvature to mark the site for the beginning of the flap.

40 days succumbing from what appears to have been a perforation of the œsophagus by extension of the carcinoma and bronchopneumonia. In 1876 Verneuil (34) of Paris using Lister's antiseptic technique obtained the second recovery and in 1879 Letit (23) collected 41 cases with 7 recoveries and mortality of 83 per cent. Ashhurst (1) in 1893 in a series of 306 cases gives the mortality as 64.9 per cent. DaCosta gives the mortality in malignant cases as 50 to 55 per cent and in the non-malignant as 8 to 10 per cent. Our mortality has been 18 per cent in 17 cases.

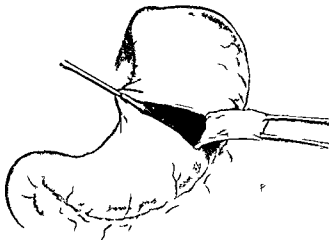


Fig. 4 The clamp has been removed and replaced to grasp the entire thickness of the cut edge of the stomach wall and the flap has been completely raised

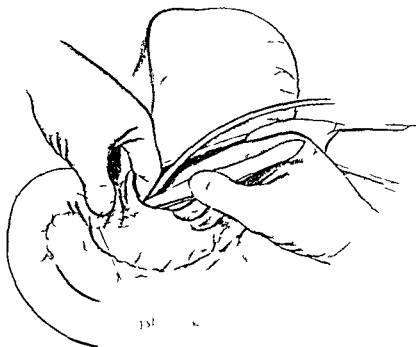
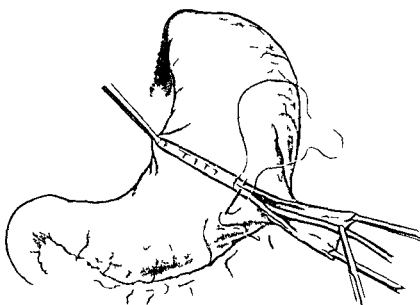


FIG 5 I t k t l f J k t b t l k l t l l r u t t h l l u m



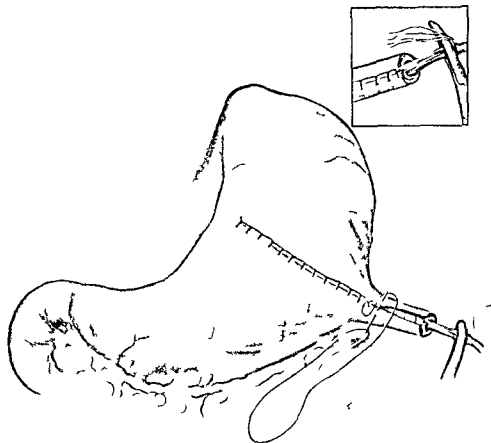
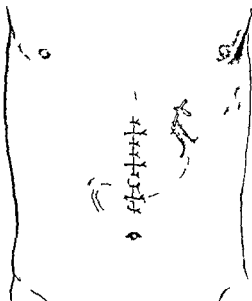
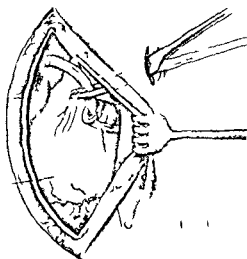


Fig. 7. Suture of the mucous layer has been completed and the suture cut. The tube is secured to them by a clamp. Suture of the external opening is completed.

Perhaps no operation so clearly conceived and so relatively simple in performance has been attended by such disastrous results before its first successful execution. The surgical pioneers whose faith in its practicability was finally justified were supported in their repeated attempts by the conviction of the analogy between accidentally acquired fistulae and those which they attempted to construct. They were all impressed by the fact that autopsies showed no local cause for death in the majority of cases and that the fatal terminations were due to delay in operation and the consequent extreme inanition of the patient. In an analysis of the first 41 cases so ably reported in detail by Petit, one can not but be impressed by the practically moribund condition of the majority of the cases operated upon. In the few whose condition seemed a little less grave, some random trick of fate brought on an early and unfortunate termination. We shall refer again to this most significant factor in mortality statistics as it applies to present day figures. Through all the literature one finds a constant plea for earlier operation by the surgeon and an implied lack of confidence in the procedure by the physician.

In the pre-antiseptic days any exploration of the abdomen was extremely hazardous and much discussion is found relative to the location of the incision so as to fall directly on the stomach. Jacobi (15) injected tartaric acid and then sodium bicarbonate through a stomach tube to distend the stomach with gas, while Schoenborn (24) inflated a balloon after having inserted it into the stomach on the end of a stomach tube. It was feared that the transverse colon would be mistaken for the stomach which in these days of extended and bold exploration seems incredible. This uncertainty was due to a general lack of familiarity with the gross appearance of the several viscera. Munder (20) in 1876 made an unsuccessful attempt and at autopsy found that he had opened the transverse colon. Considering the surgical era in which he lived, one can more easily forgive his error than accept his justification of it for he complacently remarks that it makes little difference to him which viscus he opens, the principal object being to assuage thirst and that one can inject water into one as well as the other.

The successes of Sydney Jones and Verneuil aroused a new interest in the procedure and were



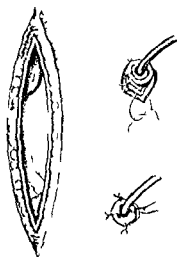
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f illo ve l b y m re frequent and earlier attempts so  
that by 1884 Gros (12) was able to collect 207  
cases. Until about the last decade of the 19th

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century the surgeon seems to have been content  
with a simple direct fistula but its manifest dis-  
advantages called for modification of the proce-  
dure. Between 1851 and 1896 five of the now  
classic methods were reported and a review of the  
subsequent literature reveals so numerous and  
such varied techniques and modifications that  
one is forced on this evidence alone to conclude  
that none is entirely satisfactory. The chief dis-  
advantage common to most methods of gastro-  
stomy are leakage with its attendant irritation and  
digestion of the skin the discomfort of constant  
wearing of the tube and the early closure of the  
fistula following removal of the tube. We propose  
to mention only those methods which are or have  
been in common usage and those illustrative of  
some special technique. For convenience they  
may be divided into two general types.

In the first type in order to prevent leakage  
there has been formed a long tract lined by granu-  
lation tissue leading from the skin surface to the  
stomach and in attempt made at the formation of  
a valve. Of this type the best known examples are  
the Witzel (36) the Stamm (29) (often confused  
with the Senn) the Marwedel (19) and the Kader  
(18). In the Witzel the rubber tube is buried



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under folds of the outer wall of the stomach in the Marwedel tube is buried between the muscular and mucous coats and in the Stamm and Kader the stomach wall is invaginated about the tube by different techniques. But since in all these procedures the ultimate result is always simply a comparatively long tract lined by granulation tissue, requiring the constant presence of a tube to prevent closure the valve cannot function and is superfluous. As their ultimate results are identical for all practical purposes there is in our opinion nothing to recommend any one of the above procedures over the others except its relative ease of performance and simplicity. Any merit that this type of operation may have is due to the long fistulous tract which offers a firm purchase on a constantly worn tightly fitting rubber tube which thereby prevents leakage. The persistence of an exposed and unhealed surface covered by granulation tissue subject to trauma infection and digestion by gastric juices is in itself an abhorrence from the standpoint of good surgery.

In the second type of operation the chief object has been to construct a fistulous tract entirely lined by epithelium unaffected by the digestive action of gastric juices and not requiring a constantly worn tube to prevent closure. Terrier (3) pulled a cone of stomach wall directly through the incision and sutured the mucosa to the skin. In the Ssabanajew Franch operation (10) a cone of stomach is pulled out of the wound and passed under a bridge of skin. Hartmann (14) and D'Agostino (5) led this cone of stomach obliquely through the rectus muscle and Hahn (13) up under and between the ribs in an effort to obtain a more efficient valve. C. Senn (8) pulled a cone of stomach through the abdominal wound and puckered it with two purse strings of catgut and a cuff of omentum about its base. This cone is sutured in the abdominal wound and the stomach depends for its continence upon the invagination of its edges which are supposed to function like venous valves. Stewart (30) and Beck ( ) have utilized the skin of the abdomen to form a plastic tube which was led through the abdominal wall and sutured to the edges of an aperture in the stomach. Edwards (7) devised an ingenious method of constructing a tract lined by mucosa which lay between the coats of the stomach wall the outer portion of the fistula however being a wound through the abdominal wall as in the Witzel operation. Tavel (31) used a section of jejunum attached to its blood supply to form a channel between the stomach and skin surface.

The Witzel Stamm Kader and Marwedel operations or their modifications are identical for

all practical purposes in their results namely the establishment of a long tract lined by granulation tissue. This tract requires the constant presence or frequent reinsertion of a tube to prevent closing. If the tube is constantly worn and fits snugly in the tract the presence of a valve is superfluous. Although the formation of a valve infers the removal of the tube except for feeding we have found that all operations of this type done by ourselves or by others (which we have followed) have been eventually forced for one or more reasons to leave the tube constantly in place (see also Keen). Should leakage occur it can usually be decreased or prevented by a tightly fitting tube constantly worn which is in effect the choice of the lesser of two evils. In inserting the tube through the granulation lined tract subjects it to trauma and the possibility of its misdirection outside the tract especially as the tract tends to close. Should the tube not fit snugly so that leakage is marked digestion may occur not only of the skin but of the edge of the tract itself resulting eventually in a large incontinent fistula totally inefficient for feeding purposes and leading to a fatal termination from malnutrition and infection. In this type of operation the discomfort of constantly wearing the tube must be balanced against leakage probable eventual difficulty and danger in the frequent reinsertion of the tube as well as the inevitable closing of the fistula should the tube be left out entirely even for a few days. Certainly only the more intelligent patient can be trusted to maintain the patency of his fistula should his dysphagia temporarily improve. De page (6) reports a case in which after a Marwedel operation for carcinoma of the œsophagus there was a marked temporary improvement in the swallowing. The patient in spite of all frequently repeated advice to the contrary left the tube out entirely resulting in early closure of the fistula. As is the rule in this disease the dysphagia soon returned and a second operation was done under the difficulties of the scarring and adhesions of the first. The fistula was not continent and the case soon terminated fatally.

In the Ssabanajew Rankin type of operation the fistula is entirely lined by gastric mucosa but comparative continence is difficult to obtain. If the formation of a valve is attempted by leading the cone of stomach wall by a more devious route through the abdominal wall or up under the tenth rib as in Hahn's operation a very serious amount of stomach wall is sacrificed thus tending to decrease the capacity of the stomach for the necessarily liquid and therefore less concentrated foods. Should the cardia of the stomach be



involved by disease or should the organ itself be small the procedure is not possible. Depage (6) says. It must be admitted that the tunnel which one professes to construct through the abdominal wall at the expense of stomach capacity is purely theoretical. If the tunnel really does exist at first at the end of a certain time it disappears and the operation of Ssabanajew (Iranck) as a result is reduced to the gastric stomy of Terrier. If the skin of the abdominal wall is utilized for the lining of the tract as suggested by Stewart and Beck, the action of gastric secretions on exposed skin should be considered. It is very questionable whether this type of lining for the fistula would often survive. The latter procedure offers no real advantage over the first type of operation because although the inner portion of the tract is lined with mucous membrane the outer portion is still lined with granulation tissue. Tavel's operation seems to us to be entirely satisfactory and completely a procedure to be withheld by the majority of cases in which gastrostomy is indicated.

It would seem then that the ideal gastrostomy should have the following characteristics:

1. The fistula must have a lining not affected by the action of gastric juices. I accept Tavel's tube the only such lining is gastric mucosa.

2. The fistula must be continuous and permit no leakage of either gastric juices or of the necessary liquid ingesta.

3. The fistula must be permanent requiring neither the presence of a tube between feedings nor its presence at longer intervals. It will be necessary for gastrostomy feeding to obviate any temporary relief from dysphagia.

4. The fistula must permit easy insertion of the tube so that the patient may feel himself free.

5. The fistula must permit easy and repeated instrumentation such as gastric lavage, retrograde oesophagography, retrograde intubation.

6. The operation must offer as its only result no unhealed or granulating surface subject to infection.

7. The operation must be possible in either a contracted stomach or a dilated cardia.

In 1901 Depage (6) first reported a procedure for the establishment of a fistula tract lined by gastric mucosa leading from the skin to the stomach cavity by the use of a plastic tube made from the stomach wall. At the time of this report Depage had performed the operation successfully in 15 cases. In presenting his report he enumerates the disadvantage of the Senn-Ssabanajew and Marwedel operations citing cases with unsatisfactory terminations. Depage through a left

rectus incision cut a stomach flap with its base upward and sewed the plastic tube into the upper angle of the wound suggesting however that it might better be led through a stab wound near the xiphoid. The operation apparently attracted slight attention. Corner (4) in 1911 highly recommended Depage's method although in his modification he did not make use of the sphincteric action of the rectus muscle. Keen dismisses Depage's technique as too complicated and difficult. Moynihan very briefly states the principles of the operation without comment.

In 1914 the late H. H. Janeway (16) reported 7 cases in which a very short plastic tube had been formed from stomach wall through a 5 centimeter incision in the left rectus. Janeway was unfamiliar with any previous similar attempt when he first devised his procedure although in his report he gives Depage full credit for precedence. His report based on 5 cases was quite brief. He subsequently modified and improved the technique which has since been developed as the routine method at the Memorial Hospital and has been employed in a series of 17 cases. We feel that this method more closely approaches the ideal gastrostomy as outlined above than any other yet devised and that the later modifications of technique and the merits of this method of gastrostomy over all others have never been adequately presented.

The modified technique may be outlined as follows:

Under local anesthesia an incision is made in the midline between the umbilicus and xiphoid (Fig. 1). When the abdominal cavity is entered the outer edges of the peritoneum are grasped and

1 per cent novocain is injected at several points about 10 to 15 centimeters from the free edges. This

will facilitate subsequent manipulation. In addition 5 cubic centimeters of novocain is injected into the gastrohepatic omentum to facilitate subsequent manipulations of the stomach. The anterior wall of the stomach is then delivered into the wound and a site chosen as far toward the cardia as the mobility of the stomach will permit the operative field being carefully packed off with laparotomy sponges to guard against contamination of the wound edges by stomach contents.

By a U shaped incision (Fig. 2) a flap is then cut about 5 by 5 centimeters with its long axis at right angles to the long axis of the stomach its base toward the greater curvature and its free end toward the lesser curvature. This flap is outlined as follows. Two Allis clamps are placed a little

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less than 5 centimeters apart as near the attachment of the gastrohepatic omentum as possible and parallel to it marking the free end of the flap. Two others are placed a little further apart about 6 centimeters directly opposite the first two toward the greater curvature and parallel to it marking the base of the flap. These clamps mark out an approximately rectangular portion of the anterior stomach wall. After doubly clamping the superficial blood vessels an incision is made between the lesser curvature and first two clamps quite near the latter and in a line with them entering the stomach cavity (Fig. 3). It is of advantage to cut first through the serosa only, grasp the mucosa and open it with a stab wound, then complete its incision with scissors which will insure against displacement of the mucosa. When the incision has been completed to just beyond the first two clamps these are removed and replaced so that they grasp the entire thickness of the cut edge of stomach wall a procedure which further insures against displacement of the mucosa when the incisions at the sides of the flap are cut. Another clamp is placed at the middle of the first incision on the lesser curvature side. This is to mark the middle of the defect left by raising the flap and the point of beginning suture of closure of the defect. From the extremities of this incision two others are made at right angles toward the respective clamps near the greater curvature and everting the flap hæmostasis is quickly effected (Fig. 4). At this time any free fluid which tends to escape from the stomach should be carefully sponged out. By the placing of one finger in the stomach directed toward the pylorus the pyloric sphincter can be located readily and by the manipulation with thumb from without it can be brought into view or even everted into the wound. It is relaxed by gentle manipulation with the finger and a soft rubber tube (25 centimeters long 4 millimeters in diameter or a No. 1 French catheter) is inserted through it (Fig. 5) and passed down through the duodenum into the jejunum the free end being clamped to the free end of the flap. Kinking or curling up of this tube within the duodenum need not cause any uneasiness for we have found that it invariably straightens itself out within a few hours. We close the wound in the stomach (Figs. 6 and 7) beginning at the clamp which marks the middle of the first incision continuing up the edges of the flap enclosing the rubber tube and forming a gooseneck tube of the flap. The closure is effected by a continuous interlocked suture of No. 00 plain catgut of the mucosa only and a continuous interlocked Lembert suture of No. 00 chromic catgut of the serous

coat. Hemorrhage need not be feared as it already should have been carefully secured against by clamp and ligature. When the sutures are completed and tied at the distal end of the flap they are cut long and the rubber tube secured to them by a clamp.

A finger is placed on the peritoneal surface and a stab wound about 2 centimeters in length is made through the outer border of the left rectus just below the costal margin (Figs. 8 and 9) proceeding through the rectus muscle in a zigzag manner so that a portion of the muscle fibers to the right of the wound are displaced to its left and vice versa. This will markedly increase the valve action. The cut edges of the anterior rectus sheath are now grasped with clamps. This is more easily done now than later. A large curved Kelly clamp is then inserted through this stab wound (Fig. 8) into the abdominal cavity to grasp the cut ends of the sutures and the rubber tube and by gentle traction from without and manipulation within the end of the gooseneck tube is brought out through the stab wound so that it projects slightly beyond the skin surface. It is fixed to the anterior rectus sheath (Fig. 9) by one stitch of No. 1 chromic catgut on either side placed through the sheath and its serous and muscular coats. The mucosa is sutured to the skin by four interrupted sutures of silk placed at the angles of the wound and at either side extending through skin and mucosa but not serosa or muscularis. The abdominal cavity is then inspected to insure proper position of the parts and the median incision closed in the conventional manner.

When the dressings are applied the rubber tube is made to extend directly through them all through an interval between the adhesive strips and through the tails of the Scultetus bandage so that feedings may be given without disturbing the dressings. The tube is fixed to the adhesive dressing by a safety pin or what is even better the tube may be encircled tightly by several turn of a narrow strip of adhesive and the pin inserted only through the adhesive. Leakage may be prevented by folding the end of the tube on itself or by plugging its end.

Feeding is begun as soon as the patient returns to the ward. Three ounces of peptonized milk are introduced every 3 hours on the day of operation and the amount increased to 4 ounces every 3 hours the day following operation. 5 ounces on the next day and so on until there is definite discomfort after a feeding indicating that the capacity of the stomach has been reached. A distressed feeling usually occurs when about 12 or 14 ounces have been introduced although after a time a full pint

can be taken without discomfort. When this amount is reached the interval between feedings may be increased to 4 hours. Saline should be given by rectum and subcutaneously for the first few days if there is even moderate dehydration.

The tube is shortened about an inch each day until the sixth day when it is removed entirely and inserted for feeding only. When the tube is entirely removed and reinserted so that food is placed directly in the stomach eggs, sugar, butter or any food capable of solution or fine suspension is added until the combined 24 hour feedings total well over 500 calories. The caloric value of the daily feeding should be carefully calculated in all cases and under no circumstance should the diet be left to the whim or caprice of the patient. An accurate calculation of an estimated diet will never fail to convince the surgeon as to the reason for failure to gain in weight. The patient may be gotten out of bed whenever it is felt that the midline incision has healed firmly.

We have been troubled with leakage in only about 5 per cent of cases. These are due to the use of a too wide stomach flap and consequently a gooseneck tube of too large diameter. The flap should be just wide enough to fit snugly about the rubber tube which should not be larger than a No. 12 French catheter. In this type of operation the continence of the fistula is due both to the collapse of the narrow channel and to the constricting action of the displaced fibers of the rectus muscle.

As all gastric stomach feedings must be liquid there is nothing to be gained by the use of a large tube except rapidity in feeding. Rapid feeding often causes uneasiness and a sense of distention or nausea quite out of proportion to the amount given. A large tube will also distend the fistula which in itself favors leakage as the tube is with drawn. Under no circumstance should a feeding tube larger than a No. 16 French catheter be used and a smaller one will usually suffice. A small tube is sufficient safeguard against too rapid feeding. Feedings may be conveniently given either by a funnel and allowed to enter the stomach by gravity or by the use of a rubber bulb syringe.

The procedure is accompanied by no more surgical shock than is any other type of gastrostomy. The wound edges should be well protected against gross soiling by stomach content which is very apt to be teeming with saprophytic bacteria if there has been slow seepage of decomposed food through an ulcerated stricture of the esophagus.

The only marked difference in technique between this operation and the Ssabanajew technique is the construction of the plastic tube which adds

only about 15 minutes to the total. A fair time for the entire procedure from the beginning of the local anesthetic is 45 minutes.

In several cases we have used Depage's method cutting the flap with its base at the lesser curvature. At first glance this method would seem the most logical for the fistula would then leave the stomach at a higher level. If furthermore the gooseneck were brought out near the xyphoid it would seem that continence would be further favored by its upward direction. But we have found that continence depends more on the small diameter of the fistula and to the sphincter like action of the rectus than to the direction of the tract. In the Janeway method the direction of the tract is also slightly upward. If Depage's plastic tube is brought out through the left rectus both the tube and the comparatively inelastic gastrohepatic omentum are placed under considerable tension and the tract assumes a rather downward direction. Therefore in using Depage's technique we have made a left rectus incision and brought the gooseneck tube out through a stab wound near the xyphoid. By so doing we substitute the rigid inflexibility of the fascia of the midline for the yielding sphincter like action of the rectus. Leakage has been greater than in Janeway's method. In either method the gooseneck should be brought out through a stab wound rather than through the upper angle of the operative wound and this stab wound should be only large enough to fit snugly around the gooseneck.

Insertion of the tube into the jejunum first suggested by Lett in 1899 (J. p. 107) permits immediate feeding and prevents any distention of the stomach until healing takes place. No other type of operation so readily admits repeated retrograde esophagography, retrograde boumanometry, gastroscopy or pylorocopy. By the passage of successively larger bougies through the fistula for 10 or 15 minutes any ordinary sized instrument can be inserted. If boumanometry or radium therapy is intended a retrograde bougie may be passed at the time of operation. The bougie is passed through the stomach up through the esophagus and out the mouth drawing a thread with it. This thread is left to emerge through the mouth and the stoma of the gastrostomy alongside the rubber tube and will serve as a guide for instrumentation or placement of radium at any time after the first week or 10 days.

Should the necessity for gastrostomy feeding be obviated for any reason no fear need be entertained for the patency of the fistula. We have had one case in which all feedings were taken through the mouth for 6 months. Dysphagia again super-

vened and the patient came to the hospital in a starving and dehydrated condition. The skin had healed about the stomal leaving a sinus about millimeters in diameter. With a closed blunt forceps this sinus was quickly dilated a feeding tube readily inserted through the fistula and feeding immediately given.

We have examined the stomachs of many of our cases dead of malignant disease after this operation and have found no evidence of any contraction or deformity. The fact that most patients will take 16 ounces at each feeding seems sufficient evidence that there is little decrease in stomach capacity. We have repeatedly and successfully performed the operation in the presence of marked neoplastic involvement of the cardia.

In this operation the disadvantages of the other types are largely overcome namely leakage and its sequelae the discomfort of a tube constantly worn and the danger of closure of the fistula. In short it combines all the advantages attempted in other types a fistulous tract lined by epithelium not subject to gastric digestion or infection a continent and permanent fistula and a stomach with a minimum deformity with a minimum decrease in capacity and gastric mucosa available for digestion.

Gastrostomy is indicated in persistent dysphagia from whatever cause in cases in which complete relief can not be anticipated within a comparatively short time. This would seem to imply that the operation should be done for carcinoma of the esophagus as soon as the diagnosis can be made which is exactly what we advocate. Carcinoma of the esophagus has up to this time resisted all methods of treatment except operative excision an operation which has an incidence of mortality among the highest of operative procedures. Gastrostomy is imperative before aggressive radiation for in such case a temporary increase in dysphagia is the rule. In carcinoma of the esophagus the patient is under a double hazard. The disease is always fatal. Death will occur from perforation if alimentation is sufficient to support him until that eventuality occurs however without gastrostomy death from starvation and water deprivation practically always precedes perforation. The best palliative treatment of the disease then is one which will prevent death from starvation and defer perforation longer than would otherwise be possible. Gastrostomy does exactly this and offers the patient a few months or even several years of comparative comfort. There is often a temporary improvement in the dysphagia after gastrostomy due to decrease in inflammation and swelling about the stricture. The removal of

swallowing as a cause of irritation undoubtedly delays extension of the disease into the mediastinum trachea or neighboring blood vessels and lessens the chance of metastasis. We do not advocate the insertion of cannulas (Myerson and others) for the reason that the presence of a foreign body in the neoplastic stricture will certainly hasten extension of the disease and perforation. We are opposed to repeated dilatation of a cancerous stricture for the same reason. We have had a case of carcinoma of the esophagus live 4 years after operation in comparative comfort. A gain of 40 to 50 pounds in weight is not uncommon and many patients return for a period to their regular occupations. A recent case returned to his trade as harness maker about three months after operation. For the last 7 months he has lost no time from his occupation except to return to the clinic at regular intervals for observation. It should be noted that this patient has gained about 5 pounds and takes a measured and calculated diet of about 5,500 calories.

In benign stricture of the esophagus gastrostomy is indicated only when progress of dilatation of the stricture is difficult and improvement of the dysphagia is at a standstill for a definite period.

The postoperative mortality of gastrostomy should be no higher than that of any operation of equal gravity certainly less than in gastroenterostomy for in the latter deeper exploration and more extended handling of the viscera is required. The mortality of gastrostomy depends not so much on the technique employed or on the unusual skill of the operator as on the condition of the patient. The drop in mortality from 85 per cent in 1879 as reported by Pettit to about 6 per cent today is undoubtedly due largely to earlier operation and consequently to a more favorable condition of the patient. If every case of dysphagia could be promptly investigated and the indications for gastrostomy appreciated by the physician the mortality of this operation would be negligible. Comparative statistics indicate the degree of irritation of the patient rather than the relative value of any method or the skill of any operator. Although our statistics compare favorably with other observers we do not advance this as an argument for the method we employ but will rest its merits on the comparative comfort of the patient on the length of life and on the near approach of the Janeway method to the ideal gastrostomy which we have outlined.

We repeat again that gastrostomy should always be done as soon as the diagnosis of carcinoma of the esophagus is made and before there is marked loss of weight. The X-ray usually suffices to make

the diagnosis although it can be definitely proved by esophagoscopy. It should also be done quite early in a benign stricture resistant to treatment. We have had two cases of persistent cardiospasm in which the operation undoubtedly saved life until the condition could be otherwise relieved.

## SUMMARY

1. A consideration of the most common methods of gastrostomy reveals that they are subject to one or more of the following disadvantages: leakage and its sequelae, the necessity of a constantly worn tube, or difficulty and danger in its reinsertion. Closure of the fistulous tract should the tube be left out and relative difficulty of instrumentation through the fistula.

A method is presented which is a modified and improved technique first reported by Janeway in 1914.

3. The Janeway method overcomes the disadvantages of gastrostomy more satisfactorily than any other method yet devised.

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# EDITORIALS

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## SURGERY, GYNECOLOGY AND OBSTETRICS

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MARCH 1978

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### EDUCATION PAYS

AS one travels about the country one is impressed by the splendid public school buildings seen in all sections. Often in poorly developed territory with few evidences of prosperity there is to be found situated on the highest point of land in the vicinity a fine public school building a source of pride to the inhabitants and regarded by them as a hostage for the future. Apparently there is an unconscious feeling that if we are to have the government we like and prosperity for all it must be through education. Every thoughtful man must wonder at times whether this education which has become almost a religion will adequately measure up to the hopes of the common people of the country.

The older generation is always uncertain about the younger generation. In the earlier time young people were kept innocent with the expectation that innocence would be a protection to their morals and ethics. The young people are more sophisticated today and perhaps because they know more of evil they will be better protected from it than they would had the innocence of past generations been maintained. In the days of my

youth the lady swept the filthy streets with her skirts. The short skirts of today are at least more sanitary.

The common man the average citizen is intellectually forms 50 per cent of the population. About 15 per cent of the population are above the average in intelligence. In this 15 per cent unfortunately there are with the sound thinkers the froth the pink socialists and the near philanthropists citizens who make gestures but who fail to follow them up by good deeds and who are as a group unorganizable. The 35 per cent below the average in intelligence are in the boy scout stage mentally and unfortunately are too readily organizable. The demagogue more effectively appeals to their prejudices than the statesman does to their mentality. The social and economic burden of the common man is a heavy one he is truly the backbone of the country.

It is easy to philosophize the philosopher is said to be one who bears with equanimity the sufferings of others. These remarks are made as a prelude to the corollary that education does pay.

Members of the Legislature of the State of Minnesota I say with all the pride natural to a native of the state are above the average in intelligence. The material resources of Minnesota are largely agricultural mining and industrial and the legislators of the state are representative of these fields. In the session of the Legislature before the last to our surprise the term for bringing malpractice suits was shortened from six years to two years and many improvements in the Medical Practice Act of the state were passed without

difficulty During the last session of the Legislature under the leadership of an active legislative committee headed by a former president of the Minnesota State Medical Association Dr Herman M Johnson a basic science medical bill which provides that those who practice medicine in the future must have sound fundamental education in physiology anatomy and the basic sciences was passed by a vote of 61 to 2 in the Senate and 111 to 7 in the House An antivivisection bill was defeated in committee without effort there is reason to believe that had it come to vote not to exceed five votes would have been cast in its favor The bill for military training in the University of Minnesota which had been stoutly assailed by the pacifists was reaffirmed by legislative enactment by a 4 to 1 vote and lastly the bootleg theology of the anti evolutionist was turned down almost unanimously by an exasperated legislature Even ten years ago I believe our legislators would not have dealt so intelligently with the arguments presented during the last session

W J MASON

### TUBO-OVARIAN DISEASE

**T**HE fact that much of the surgical literature of the past few years has dealt with lesions in the upper abdomen has at this time offered an opportunity for a short discourse on tubo ovarian infection

Over 90 per cent of all tubo ovarian infections are due to the gonococcus however some few cases result from either puerperal infection or the improper use of the curette Gonorrheal infection of the tubes is usually bilateral condition The tubes become closed early while in tuberculosis they remain open They will be only slightly congested and oedematous throughout the entire coats in the early stage and later the infection reaches the fimbriae when it causes the tubes to close and

form a pocket of pus Occasionally the pus will escape into the abdominal cavity and cause a general peritonitis I frequently after the tubes become closed and a pus pocket has formed the fimbriae become attached to the ovary and a destructive infection is caused As a result of the peritoneal inflammation the infected tubes and ovaries and the heavy uterus drop low down under the broad ligaments and form a conglomerate mass called a tubo ovarian abscess This mass is usually fixed to the uterus and pelvic floor and covered over by omentum and intestines

The diagnosis is made from the history of urinary frequency with burning and stinging the characteristic yellow discharge the occasional finding of gonococci in a vaginal smear and from the finding of a fixed uterus or mass in the pelvis either alone or associated with a fibroid uterus In some of the longstanding cases a diagnosis of typhoid fever tuberculosis or malaria might be made should the physician not happen to make a vaginal examination

In acute salpingitis some few cases will clear up by rest in bed douches and expectant treatment but the majority will have evidences later of a chronic pelvic infection In view of the fact that some few cases entirely recover one must treat conservatively at the initial illness but if there has been a history of previous attacks or a fixed uterus or a mass felt we have no hesitancy in operating during an acute exacerbation This is done for two reasons first the mortality rate is no higher in our experience than that following operation during an interval as these patients though extremely sick stand operation well second the average person is not able financially to remain in a hospital very long

There are a few points which we would like to mention regarding the treatment of these cases

1 In operation for tubo ovarian disease due to gonorrhœal infection a definite line of cleavage may be followed in the separation of the structures while in cases due to puerperal infection no cleavage is evident because the infection is systemic with no tendency for localization

To obtain the best results it is absolutely necessary to do a complete removal of all infected organs for if not future trouble will necessitate secondary operations. When the ovaries are infected and destroyed conservative surgery leads to later operations. The symptoms of nervousness that follow are not severe but in fact slight as compared with those following the removal of the ovaries for other conditions. It is of particular interest to know that the negro does not suffer from any nervous discomforts after bilateral oophorectomy.

3 The uterus rarely needs to be removed unless it contains fibroids or one or more abscesses because it will usually return to its normal size after the removal of the infection. Uterine bleeding which occasionally is seen in cases of pelvic infection will stop after the removal of the diseased tube the ovary or both.

4 Though they are extremely sick and are being subjected to operation during an acute attack these patients stand operation well and even better than they could for almost any other abdominal condition.

5 It is absolutely necessary to make a thorough examination of the structures in the lower abdomen to separate adhesions and to examine the intestines (especially the lower ileum) as this will lessen postoperative obstruction.

6 In an occasional chronic case drainage will not be necessary but as a rule drainage with gauze by which means the intestines can be packed off from the true pelvis will afford the best ultimate results and a minimum of postoperative complications.

In the South where a great deal of surgery is done among the negro race more operations are performed for tubo ovarian disease of the child bearing negro woman than for all other conditions combined. In this race of people a case of primary appendicitis is not common for in most cases gonorrhœal infection is the primary cause for surgery and the appendix secondary. Many of these people are also infected with syphilis but this is no barrier to surgery in the pelvis.

HUGH S. BLACK



# MASTER SURGEONS OF AMERICA

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WILLIAM HOLME VAN BUREN

FEW men in this country have known so much about the surgery of their time as did Samuel D. Gross of Philadelphia and above all few were in a position such as he was to estimate the distinction reached by their contemporaries in American surgical life. In the diary published in connection with his autobiography Gross has this entry under the date of March 5 1883: "This ought to be a sad day for me. One of our most distinguished men has dropped out of our ranks. Van Buren died this morning at his house after a protracted illness. The opinion thus freely expressed by Gross was shared by all those in this country who were in a position to know the work and the character of Van Buren."

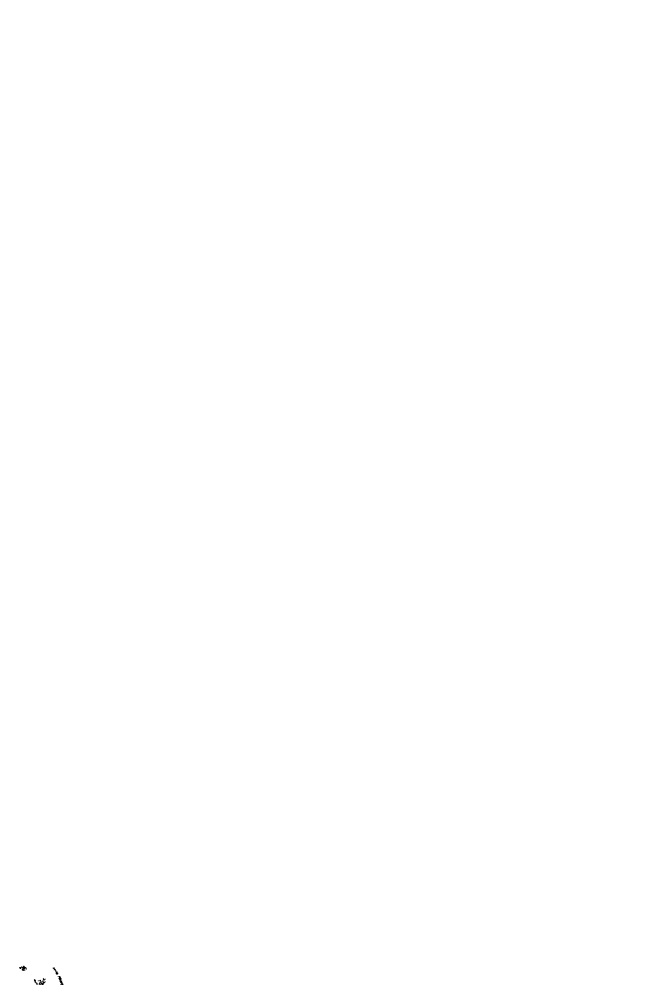
In writing the *History of Medicine in New York* (New York 1919) I came to realize that Dr. Van Buren had to be given a place of honor among the greatest of the men who in our Empire State have devoted themselves to the creation of a surgical specialty. His textbook was known not alone in this country but throughout the English speaking world and his name was known everywhere in the medical world of his day.

Van Buren's education was interesting. He was expelled from Yale for what surely must have been a school boy prank for he then spent 2 years studying medicine in the University of Pennsylvania and was ready for graduation but had not reached the age of twenty one at which graduation was permitted. He therefore went to Paris to fill in the time. There he was a member of the house staff of *L'Assistance Publique* under Velpeau who was considered the greatest surgeon of his time. Van Buren had to work hard but merited and received the approbation of his chief. In the clinic he met Valentine Mott the well known New York surgeon who was in Paris picking up what was latest in surgery. Van Buren returned to New York to become the assistant and then the son in law of Mott.

He received his degree of doctor of medicine at the University of Pennsylvania his thesis being the starch and dextrin bandage which he had seen used so successfully in Paris. This initiated the treatment of fracture by immovable apparatus. The value of Van Buren's essay was recognized by the faculty who secured its publication and afforded its author the opportunity for a public demonstration. This attracted wide attention and toward the end of his life Van Buren used to



WILLIAM H VAN BUREN  
1819-1883



saw that the audience which assembled to see him apply his bandages was the largest professional gathering before which he ever appeared. After this he was a marked man in the profession.

Van Buren took the competitive examination for entrance into the army medical service and passed first ahead of men who afterward became surgeon-generals of the United States. He served for some years in the army and then contracted a severe malaria which undermined his constitution and probably shortened his life. He returned to New York, married Dr. Mott's daughter and soon as professor of anatomy in the medical school of the University of New York became very prominent in the medical teaching and professional life of New York City. During the Civil War President Lincoln offered to make Van Buren surgeon-general and when for excellent reasons he refused the President insisted on having him name the candidate he deemed most suitable for the position. No wonder that alma mater Yale made up for step-motherliness earlier by conferring an honorary degree on him.

At the end of the Civil War Van Buren was selected as professor of the principles of surgery in Bellevue Hospital Medical College at that time one of the leading medical schools in the country. He occupied this position for some 16 years until his death in the early eighties but he became known particularly for his clinics in the surgery of the genito-urinary organs. His father-in-law, Valentine Mott, had become famous as a lithotomist. Genito-urinary operations occupied the place then that abdominal operations usurped afterward. In those days it was men rather than women who had to undergo the majority of serious surgical operations.

After many years of special study of the subject Van Buren in conjunction with Edward L. Keyes wrote an exhaustive treatise on *The Diseases of the Genito-Urinary Organs*. This was issued in edition after edition for years and was considered the best authority on the subject in this country. It gave Van Buren a reputation abroad and since he had made some of his studies in Paris it was received with favor by the French who were at that time the leaders in the specialty. Until his researches in the matter the genito-urinary diseases had been made entirely too little of. Our present recognition of their significance dates from this publication.

Besides the textbook in which he collaborated with Keyes Van Buren published a volume of some two hundred pages on surgical cases. He called it *Contributions to Practical Surgery* and the volume would remind one in many ways of the clinical lectures so popular in our day. The book illustrates very well what an excellent teacher Van Buren must have been and makes it very easy to understand why his students thought so much of him. He did not limit his work entirely to genito-urinary surgery for he published a small volume of *Lectures on Diseases of the Rectum* which had been delivered at Bellevue Hospital Medical

College in 1870 and published by Appleton that year. The annotated copy that I have had before me while writing this sketch shows that he was preparing to issue another edition of it not long before his death. It is a valuable practical manual of the treatment of diseases of the lower bowel.

In the memorial address read before the New York Academy of Medicine April 5 1883 of which body Van Buren had been vice president Edward L. Keyes who as I have said had been associated with Van Buren for many years did not hesitate to say that his death at the comparatively early age of 63 years terminated a career of no ordinary brilliancy and left a place in the ranks of the medical profession which will probably long remain unfilled. To Van Buren and his father in law Valentine Mott New York owes more than to any others its pre-eminence in the teaching of medicine which developed just before and after the middle of the nineteenth century. As Keyes said Dr Van Buren left behind him a reputation surpassed by no one for high refinement as a gentleman classical polish as a scholar unequalled grace as an operator clearness force elegance as a teacher profound judgment as a physician. He has left his mark upon the profession he adorned and has elevated its tone and its dignity by his uncompromising exaction of respect for the science and art in which he dealt—a respect which he insisted upon from all who approached him in the consulting room or elsewhere.

JAMES J. WALSH



GABRIELIS FALL  
M V T I N E N S  
PHILOSOPHI, AC M  
PRAECLARISSIMI

De Parte medicinae, quae Chyrurgia nunc  
in lib Hippocratis de uulneribus  
dilucidissima interpretat

*Nunc primum castigatissima ac varis locis  
sunt physicae sunt chyrurgicae atque potissi  
ae sclopetis proueniunt eorumque curation*

Secunda editio  
CVM PRIVILEC



Apud Paulum, & Arto

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

By WILFRED BROWN, M.D., F.R.C.S., OXFORD

### THE SURGERY OF GABRIEL FALLOPPPIUS

PADUA calls to mind the period when the surgery of the sixteenth century was making its brave attempt to escape from the toils of the Galenic ideas and to gain the heights of sounder knowledge based on the anatomy of the human instead of the animal body. Padua lays claim to being the oldest city in northern Italy and its inhabitants claim descent from the fabulous Trojan Antenor. However chimerical these claims may be the city through its university crowned the cradle song not only of infant medical science but also of art and poetry and other sciences for in its roster we find the names of Giotto and Donatello the artists Bembo and Tasso the poets and Galileo the great astronomer. The names in the roster of brilliant medical men are legion for the fame of the Paduan school drew them nearly all to its walls. When Frederick II overthrew the Lombard rule and established his vicar to rule over Italy in 1236 he immediately set about founding the university completing the task in 1238. From this date on though there was constant warfare and restlessness the University survived and when the city finally passed under Venetian rule in 1405 the opportunity came for advancement in the arts and sciences. The arts came first and it was not until the early sixteenth century that medical science came into its own.

Though Padua and its university call to mind the names of its alpha and omega Vesalius and Harvey there are many others and among them not the least was Gabriel Fallopppius who was born in Modena in 1523 nine years later than his famous contemporary Vesalius under whom he probably studied after he had completed his preliminary education with Antonio Musa Braccavola in Ferrara. He became in turn professor of anatomy at Ferrara and Pisa and finally in 1551 at the age of twenty-eight was appointed professor of anatomy surgery and botany at the University of Padua holding the position until his death in 1564 at the age of only 39 years.

Though we know Fallopppius best as an anatomist he was also professor of surgery at the University and his reputation as a practicing surgeon spread beyond the confines of his native land to both France and Greece. With his full life and many duties it is not surprising that only one of

his works the *Observationes Anatomicae* was published during his lifetime in 1561 at Venice and again in other cities in 1564. There are however many works which pass under his name which were issued anonymously but in only one is the word surgeon used in the title. Apparently wounds only were considered true surgical conditions for in this work which treats of that subject alone the title reads "The very lucid interpretation of the famous Philosopher and Physician Gabriel Fallopppius of Modena concerning that part of medicine which is called surgery including also wounds of the head from the book of Hippocrates now for the first time corrected and augmented with various discussions on medical and surgical and particularly the consideration of the infection which arise from wounds and their cure." Second Edition with Privilege Venice. At the house of the brothers Paulus and Antonius Meietus Bookseller of Padua 1571.

Fallopppius must have been a remarkable teacher for above all things else the book demonstrates his ability to place his material before his hearers in a clear and logical sequence. Beginning with the thing that must be known in order to treat wounds properly he states the definition concurred in by all authors that a wound is a solution in continuity. From that point he proceeds to a classification of wounds and their symptoms prognosis and the various signs of healing. He is dealing one should bear in mind with a comparatively new type of wound in the gun shot wound. Consequently his discussion of the removal or failing removal the inclusion of foreign bodies is interesting. He advises removal but states that foreign bodies may in some cases remain without particular harm. In discussing wounds of deeper organs he differs from the ancient authors in holding that wounds of these are not necessarily fatal and in support of this contention cites not only his own experience but also that of Guy de Chauliac. His description of healing by primary and secondary intention is lucidly and simply expressed and we gather that his students had a clear idea of Fallopppius' opinions at least at the end of their course of lectures.

When we remember that this man hailed by some historians as a greater anatomist than Vesalius at an age of less than 40 years had a grasp of the literature of his predecessors such as he demonstrates in this volume we marvel at his efficiency and ability.



GABRIELIS FALLOPPII  
M V T I N E N S I S  
PHILOSOPHI, AC MEDICI  
PRAECLARISSIMI

De Parte medicinæ, quæ Chyrurgia nuncupatur, nec non  
in lib Hippocratis de uulneribus capitis  
dilucidissima interpretatio

*Nunc primum castigatissima ac varis locupletata discursibus  
cum physicis cum chyrurgicis atque potissimum afflictiis qui  
ex sclopetis proueniunt eorumque curatione*

Secunda editio  
CVM PRIVILEGIO



VENETIIS

Apud Paulum, & Antonium Fr. de tictos Patavina Bibliopolas 1572.

# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

By ALFRED BROWN, M.D. F.A.C.S. OMAHA

### THE SURGERY OF GABRIEL FALLOPPPIUS

PADUA calls to mind the period when the surgery of the sixteenth century was making its brave attempt to escape from the toils of the Galenic ideas and to gain the heights of sounder knowledge based on the anatomy of the human instead of the animal body. Padua has claim to being the oldest city in northern Italy and its inhabitants claim descent from the fabulous Trojan Antenor. However chimerical these claims may be the city through its university crooned the cradle song not only of infant medical science but also of art and poetry and other sciences for in its roster we find the names of Giotto and Donatello the artists Bembo and Tasso the poets and Galileo the great astronomer. The names in the roster of brilliant medical men are legion for the fame of the Paduan school drew them nearly all to its walls. When Frederick II overthrew the Lombard rule and established his vicar to rule over Padua in 1236 he immediately set about founding the university completing the task in 1238. From this date on though there was constant warfare and restlessness the University survived and when the city finally passed under Venetian rule in 1405 the opportunity came for advancement in the arts and sciences. The arts came first and it was not until the early sixteenth century that medical science came into its own.

Though Padua and its university call to mind the names of its alpha and omega Vesalius and Harvey there are many others and among them not the least was Gabriel Fallopppius who was born in Modena in 1523 nine years later than his famous contemporary Vesalius under whom he probably studied after he had completed his preliminary education with Antonio Musa Braccavola in Ferrara. He became in turn professor of anatomy at Ferrara and Pisa and finally in 1551 at the age of twenty eight was appointed professor of anatomy surgery and botany at the University of Padua holding the position until his death in 1562 at the age of only 39 years.

Though we know Fallopppius best as an anatomist he was also professor of surgery at the University and his reputation as a practicing surgeon spread beyond the confines of his native land to both France and Greece. With his full life and many duties it is not surprising that only one of

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## REVIEWS OF NEW BOOKS

ANY product of the pen of B. clere dean of French roentgenologists will be found to be worth while. The volume on radiology just published covers the present day knowledge in the X-ray field of interpretation of medical and surgical conditions. The illustrations in any work on the subject of X-ray diagnosis are of even greater importance than they are in almost any other branch of medical endeavor. In producing this book the authors and bookmakers have rendered a distinct service by the excellent quality of the illustrative material. Few works on this subject equal it in this respect. Occasionally I cut it found upside down having escaped the editor's eye. No practical application of X-ray has been omitted and the subject matter covers the most recent developments such as the opaque filling of the respiratory tract, the gall bladder usually at an angle, other similar procedures. Its four hundred odd pages are filled with material that anyone conversant with the French language will find informative. All authorities on the subject of diagnostic roentgenology. The authors announce the preparation of a second volume which will treat the subject of radiation therapy, thus offering a complete work on the subject.

WORD'S BIT

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While the subject matter is in French all of the plates are explained with captions in English Italian Spanish and German as well. Normal evacuation pelvic extent in various forms of hydro nephrosis ureter and pelvic calculi movable kidney.

neoplasms of the kidney and renal and ureteral anomalies are discussed in the order named.

VINCENT J O CONOR

THE ground work of this monograph on the Thom splint is the work of the late Hugh Owen Thomas and more particularly the principles of his knee joint splint. The British mortality from shock in cases of compound fracture of the femur as reduce 1/3 from 80 per cent in 1916 to 15.6 per cent in 1917 chiefly as the result of the immobilization secured by the early application and the use of the Thomas splint.

The author has considered every detail of the apparatus which is described from the standpoint of efficiency and comfort. The accuracy of the adjustment of the splint and the action of mechanical devices designed to lessen the burden of suffering are important factors in obtaining good results and in maintaining the morale of the soldier. In the preliminary consideration the author gives a concise account of these important factors in the consideration of fractures. He describes the position of the limb for ankylosis of the various important joints. The ideal treatment is given in detail. The methods used to secure alignment and immobilization are those so successfully used by the author during the late war. The application of the Thomas splint to fractures of the lower extremities is given in great detail and illustrated by excellent photographs. Fractures of the bones of the upper extremities are considered and the various types are illustrated. There is a chapter on the wounds of the soft tissues. The author emphasizes the importance of a careful study of good roentgen-ray film

In the appendices the specifications of the Thomas knee joint are given in great detail as are the author's splint boxes for the arm and leg. Methods for applying Snelcan glue or gelatin are given and the excellent table of material required in the treatment of various fractures. The subject is very well handled and the illustrations are of the whole excellent. It is a book to be recommended to every one doing industrial or trauma surgery.

PHILIP LE TON

**D**EDICATED to Dr Adolf Meyer this new textbook of *Psychiatry* by two British writers aims to emphasize the biological viewpoint of the American school of psychiatry. This involves what might be called the longitudinal method of studying certain cases whose mental illness are regarded as the



# AMERICAN COLLEGE OF SURGEONS

## 1928 CLINICAL CONGRESS IN BOSTON

THE eighteenth annual Clinical Congress of the American College of Surgeons will be held in Boston the second week in October beginning Monday October 8 continuing until Friday October 12. Headquarters will be established at the Stratler and Copley Plaza hotels. At the former hotel the large ballroom and adjacent foyer the Gymnasium and other large rooms on the mezzanine floor will be used for registration and ticket bureaus bulletin rooms executive offices exhibits etc. The ballroom at the Copley Plaza will be used for the evening scientific meetings with the exception of the Presidential Meeting on Monday evening and the convocation on Friday evening which will be held in Symphony Hall.

The clinical program being arranged by the committee will include clinics and demonstrations at the following institutions: Harvard University Boston University and Tufts College medical schools and the following hospitals: Beth Israel Boston City Boston Dispensary Boston Lying In Peter Bent Brigham Robert Brigham Cambridge Carney Children's Deaconess Faulkner Free Hospital for Women Huntington Memorial Long Island Massachusetts Eye and Ear Infirmary Massachusetts General Massachusetts Homeopathic New Eng-

land Baptist New England Hospital for Women and Children and St. Elizabeth's.

A committee on arrangements has been organized which includes the following:

I. J. C. C. C.	Otto J. H. Ma
Chas. C. M. Ste	D. F. J.
S. J. J.	W. E. Ladd
J. H. D. Adams	F. H. L. Hey
N. H. Hall	Hal. v. Lod
F. K. G. Balch	I. d. B. I. d.
W. J. S. B. G.	R. H. Mill
J. I. M. M. B. G.	W. J. Mart
D. d. C. r	H. I. Mo. h.
A. H. L. Ch. t.	D. H. M. o.
J. H. C. u. s. h. m.	Fra. K. N. S. New. l.
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C. S. D. l.	J. ph. I. Sta. t.
H. r. W. D. k. n.	A. W. St. arns
A. W. D. l. y.	J. m. W. Stone
D. d. F. I. l.	J. on. T. Sw.
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W. l. m. I. C. a.	Wym. Whittemo. e.
F. I. t. B. C. n. l.	Ha. Z. n.

The hotel situation in Boston has been greatly improved since the last session of the Clinical Congress in October 1927 by the building of new hotel and the enlargement of some of the older houses. There are now ample first class hotel accommodations in Boston for all who will attend.



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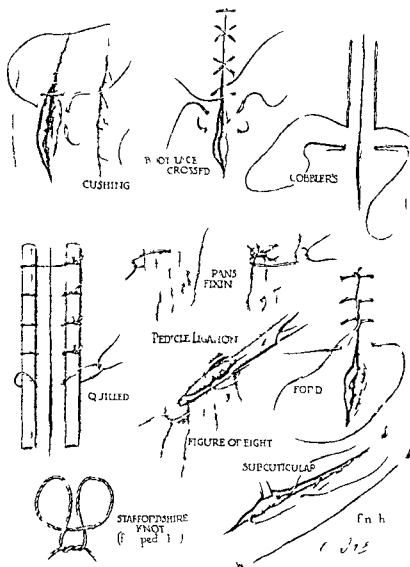
J. I. J. Cotton	Otto J. Herman
C. J. J.	David F. Jones
Chas. C. M. ter	W. I. Ladd
S. J. J.	F. H. L. Hey
Joh. D. A. lam	Halcyon Loder
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M. de S. Begg	W. J. M. xt.
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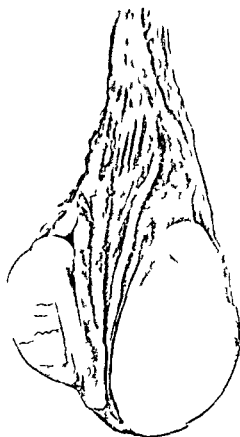
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# SURGERY, GYNECOLOGY AND OBSTETRICS

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APRIL 1978

NUMBER 4

## SARCOMATOUS TUMORS OF THE TESTICLE<sup>1</sup>

By HAROLD DEW, F.R.C.S., F.A.C.S., MELBOURNE AUSTRALIA  
Surg. to O.T. P. & T. M. Ibo. H. P. I.

In a recent monograph (13) I emphasized the confusion that had existed for many years with regard to the nature of round cell tumors of the testicle. For long it was stated in many textbooks that sarcoma was the commonest tumor of this organ and that it was a peculiar exception to sarcomatous tumors in general in that it produced metastases in the lymphatic glands. As pathological observations accumulated and these tumors were studied in greater detail it was found that many testicular tumors were in reality teratomatous in nature. The pioneer work of Wilms (49) Pick (39) Chevassu (7) and Nicholson (36) among others showed that about 50 per cent of these tumors contained derivatives of one or all of the three primary germinal layers although derivatives of any one of these layers could grow in excess and produce what at first glance seemed to be a homogeneous tumor. Another important fact was recognized, i.e. that any of the derivatives could undergo malignant change with the production of a carcinoma or a sarcoma, the development of a carcinoma from the hypoblastic elements being most frequently seen. Various writers including Waldeyer (47) Breus (4) Malassez (30) Carnot and Marie (5) had described peculiar testicular tumors which characteristically showed invasion of the veins with the formation of an intravascular growth sometimes extending through the vena cava to the heart. The French authors called these

sarcome angioplasique. Wilms (50) and Schlegelhauser (45) first pointed out the now well recognized fact that these are in reality carcinomas, the majority being chorionic in type.

The other common tumors of the testicle are soft homogeneous growths resembling sarcomata both microscopically and macroscopically and on account of the variability in the size and arrangement of the cells they were often regarded as such. Ehrendorfer (17) and Krompecher (9) regarded many of them as alveolar sarcomata, other observers classed them as endotheliomata but Kocher and Langhans (6) first suggested that the majority were carcinomata and that their method of producing metastasis in lymph glands was not surprising. Later Chevassu (8) Nicholson (37) Ewing (18) Dew (14) and Bell ( ) among others emphasized the essential distinction between these growths and the sarcomata. It is conceded by the majority of observers that they are derived from the cells of the seminal epithelium and Chevassu has coined the appropriate name seminoma for them. While recognizing their undoubted carcinomatous nature Ewing (18) classified them as embryonal carcinomata and regarded them as a one sided development of a teratoma.

The writer (14) has reviewed this problem elsewhere and has brought forward conclusive evidence in favor of the view that they are

<sup>1</sup> From the Walter and Eliza Hall Institute of Research in Pathology, Melbourne.



Fig. 1. Teratoma of the testis. The mass is composed of various tissues, including muscle, fat, and connective tissue, and is surrounded by a capsule.

both histogenetically and clinically a group distinct from the teratogenous growths. They are as a rule composed of comparatively large cells with hyperchromatic nuclei and little cytoplasm and their stroma is often infiltrated with small lymphocyte. There is no doubt that taking histological appearances into consideration there may be great difficulty in distinguishing many of them from the sarcomata. Bell (2) who upholds the view that they are derived from the seminal epithelium has recently emphasized this diagnostic difficulty and in spite of their epithelial origin has adopted the term "carcinosarcoma" for those which histologically show a sarcomatous appearance. He states that this feature is probably related to the meso-

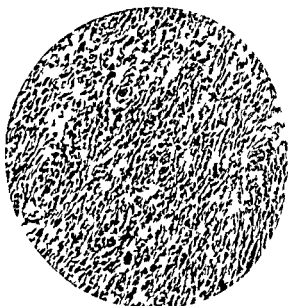


Fig. 2. Teratoma of the testis. The mass is composed of various tissues, including muscle, fat, and connective tissue, and is surrounded by a capsule.

thelial origin of the seminal cells and to reversary tendencies. It would seem that even histologically the carcinomatous characteristics predominate and that as their pathological and clinical behavior is carcinomatous their histological variations should not be overemphasized. The term "carcinosarcoma" is an unnecessary and a somewhat confusing addition to an otherwise overburdened nomenclature. For a similar reason the term "mesothelioma" introduced by Adams (1) has never gained acceptance.

If both the e groups of tumors are excluded it will be found that only about 1 per cent of testicular tumors can be regarded as primary sarcomata. True sarcomata however do occur and the previously unreported case here recorded illustrates the various pathological types.

The sarcomatous tumors arise from the following tissues: (1) the mesoblastic elements of a teratoma; (2) the intertubular connective tissue of the testis and epididymis; (3) the coverings of the testis and the spermatic cord; (4) blood or lymph borne metastatic emboli.

#### TERATOGENOUS SARCOMATA

The mesoblastic elements of teratogenous tumors give rise to the varied cellular stroma

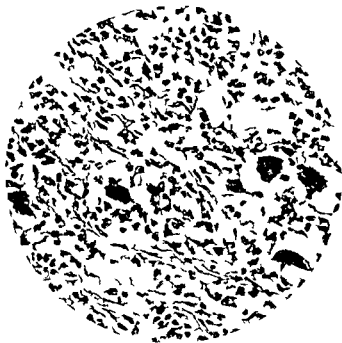


Fig 3 Section of one portion of tumor Case 1 showing giant cell  $\times 360$

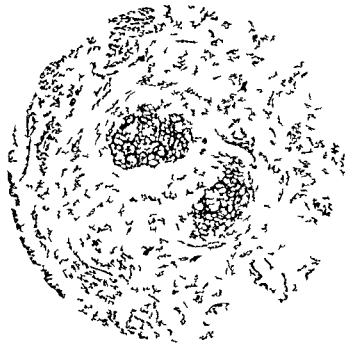


Fig 4 Section Case 1 showing teratomatous elements cartilage and the formation of glandular acini

of these growths. This in many cases retains a strikingly embryonic appearance so that the diagnosis of mixed sarcomatous tumors so common in the older records is not surprising. Other types of tissue such as cartilage, striped or unstriped muscle, lymphatic, myomatous or lipomatous tissue may occur and their occurrence in various proportions has given rise to the diagnosis of many types of tumor, their name depending on the predominating tissue present. It is now recognized that the presence of any heterogenous tissue in a testicular neoplasm is presumptive evidence of the teratogenous nature of such a growth. Malignant change in any of the mesoblastic derivative with the production of various types of sarcomata is rare but has been recorded. There seems no doubt that many of the cases of spindle cell sarcoma of the testis described by earlier observers were in reality teratogenous, this fact being unrecognized in most cases because sections from all parts of the tumor were not examined. This appears to be so in the case recorded by Kocher and Langhans (6), Ehrendorfer (17), Monod and Lericq (34) and DeBarnard (1). In examining an old museum specimen labelled plexiform spindle cell sarcoma, Wilms (49) found cysts lined with squamous and colum-

nar epithelium and areas of cartilage thus proving its teratogenous nature. Ewing (18) is particularly insistent that great care must be exercised in spindle cell growths to exclude myomatous or other elements derived from a teratoma.

CASE 1 illustrates some of the points

CASE 1. Teratogenous spindle cell sarcoma. H. K., aged 40 years, gave a history that 8 months before admission he had injured the left testicle which became tender and swollen. It subsided somewhat under treatment by counter irritation but after a month he noticed that it was slowly enlarging. This enlargement had become more noticeable during the last months. He had had no pain since the accident and otherwise felt well. Examination revealed a large pyriform tumor extending to the external abdominal ring. The veins of the scrotum were very large but the skin was freely movable over the mass. Neither the testicle nor the epididymus could be differentiated. No testicular sensation was elicited. The tumor was opaque to transillumination. The other testicle appeared normal. Palpation in the epigastric region revealed nothing abnormal. The other organs appeared healthy and he stated that he felt well and had not lost any weight. Operation was advised and the radical operation for teratoma testis was carried out. No enlarged glands however being discovered in the lumbar region although on account of the amount of retroperitoneal fat present a perfectly clean dissection was impossible. Four months later the patient returned complaining of shortness of breath, loss of weight and



Fig. 1. (1) m f t m f m C h type 1

perf t l t the cav t The cord showed some hypertroph and as slightl filt tel with ne gr th t lo t part The surroundin crotal t ues were n tin led The e e e hard areas n c t o a v ugg tion that it conta ned terato mat u element

M p llv Sect ons ere take from various p o t o n f the cut su f ce and exami ed micro- c j ic ll It found that the g eater part of the tum r a composed of homogeneou spindl e cell are m t u s t ue (Fig ) I this the cell wer g ll a diffuse irregular man e and i ho l s an l v ere embed led in a h e intercellul r mat ix In p ts the cell e n nt mat elat onsh p with blood vessel many of which appeared simply as

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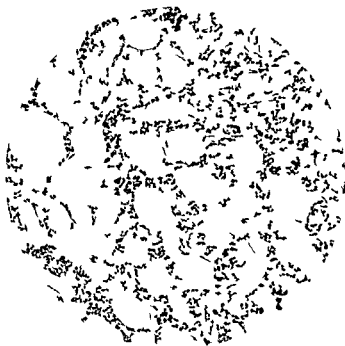


FIG. 7. Section on of tumor in Case 2 showing invasion of fat by sarcomatous cells.  $\times 5$ .



FIG. 8. Section from tumor Case 2 showing area of calcified cartilage.  $\times 50$ .

*Nature of the tumor* The tumor is certainly an example of sarcoma developing in a teratoma. The presence of giant cells among the spindle cells in sarcomatous tumors of the testis has been referred to by Benenati (3), Debernardi (12) and Chevassu (7) and is pointed out by Ewing (18) suggesting an origin from muscle fibers. This tumor almost certainly originated in this way since it contained scattered bundles of muscle fibers and in certain areas transitions between these and spindle cells. Unfortunately the metastases could not be examined. The presence of blood stained pleural effusion the rapid development and the pulmonary signs indicate that multiple metastases existed in the lungs. It is almost certain that these would have been found to be composed of pure spindle cell tissue. The appearance of an epigastric secondary glandular mass is of great interest. It may be that these glandular metastases were also of the same sarcomatous nature or it may be that as in some of the reported teratogenous cases mixed or carcinomatous secondaries were also present. The absence of carcinomatous change in the numerous sections of the primary tumor does not favor the latter view.

The following is a record of a somewhat similar neoplasm

**CASE 2.** Teratogenous lipofibrosarcoma. C. H. aged 67 years was under the care of Dr. F. Grutzner to whom I am indebted for the case history and the specimens. Twenty years before being seen he had had an attack of mumps which was complicated by bilateral orchitis which subsided. Since then he had had no children but the uninvolved testicle showed no sign of atrophy. Seven years before seeking advice his right testicle began to enlarge and he thought that he had a rupture. This swelling had gradually increased but during the latter 12 months had grown much more rapidly particularly during the last 3 months. There had never been any trauma to the organ pain had never been present and in spite of the great size and weight of the tumor he had been able to carry out his occupation of orchardist. He presented himself for examination because of the discomfort from dragging in the loins and the deformity produced by the tumor. When first examined he appeared to be in normal health the large swelling of the right half of the scrotum being the only abnormality detected. The swelling of the right scrotum was very large extending to the knee pyriform in shape and of a solid consistency. The scrotal skin was smooth not adherent but there was some chafing with mild local infection on the anterolateral aspect. The tumor was hard regular in the upper part but somewhat nodular below. Neither the testis nor the epididymis could be differentiated and as the swelling extended into the inguinal canal the cord could not be well examined. There was no testicular sensation present and the mass was opaque to transillumination. No enlargement of the lumbar or inguinal lymphatic glands was detected. The diagnosis of neoplasm was made and operation







Fig. 10. Bilateral lymphosarcoma of testis with a cutaneous nodule. One-half size.

of the comparative rarity of lipomatous tissue in such growths to be an example of teratogenous lipofibrosarcoma in which all other elements had been suppressed.

3. With this possibility in view many more sections were cut and examined and the others were carefully reviewed to attempt to discover teratogenous elements. In section No. 84 areas of calcified cartilage (Fig. 8) were discovered while in some of the sections from the peripheral part of the fibrosarcomatous areas involuntary muscle bundles and lymphoid areas were found. In addition examination of other sections showed scattered giant cells rather similar to those seen in Case 1. There seems to be no doubt that the diagnosis of teratogenous fibroliposarcoma for this interesting tumor is justified. It is suggested that in this case as in the preceding the sarcoma was probably derived from the myogenous elements of a teratoma.

#### PRIMARY SARCOMA DERIVED FROM THE CONNECTIVE TISSUE OF THE TESTIS

Two apparently distinct types of primary sarcoma of the testis have been recorded although on account of their rarity we are not yet in a position to be certain of their histogenesis. These tumors are composed of small round cells and have been usually described as lymphosarcomata: (a) unilateral lymphosarcoma—differing in no way from ordinary sarcoma as regards histologic course or metas-



Fig. 11. Section of tumor of right testis from same case as in Figure 10 from main tumor mass showing type of cell present.  $\times 130$ .

tases (b) lymphosarcoma—characterized by its appearance in both testes by its rapid growth and by the presence of multiple cutaneous sarcomatous nodules.

Lymphosarcomata of the first group are very rare but apparently authentic cases have been recorded by Nicholson (36) DeBarnardi



Fig. 12. Section of the same tumor as in Figure 10 showing infiltration of the epididymis.  $\times 75$ .



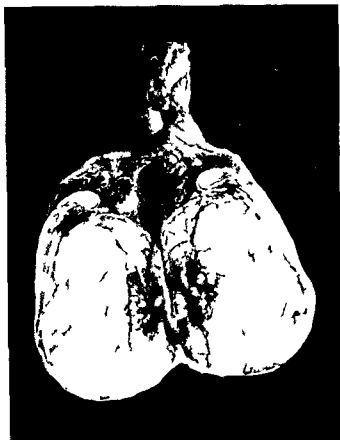


Fig. 15 Secondary embryonal sarcoma (Wilms tumor) of the left testicle. Child aged 27 months. Natural size.

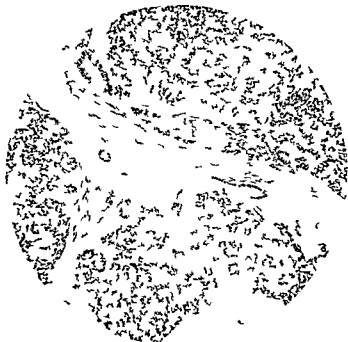


Fig. 16 Section of secondary Wilms tumor of the testis showing mixed structure.  $\times 66$ .

his bed. These nodules which were extremely numerous varied in size from 0.5 to 3 centimeters in diameter were very vascular and caused thinning and finally ulceration of the skin. They were not painful until they became secondarily infected from ulceration. The two testicular swellings increased but the effusion into the tunical sac seemed to diminish the swelling on each side becoming opaque. The epididymis on the right side appeared to be enlarged. Puncture revealed slightly blood stained fluid from the right tunica. Examination of the chest in the later stage showed some basal congestion but no signs of metastases or of pleural effusion. There was no demonstrable increase in the size of the liver or spleen nor could any tumor be felt in the abdomen. The patient gradually became cachectic and died in a state of coma 4 months after first being seen. A full autopsy was not allowed so that the pathological information available is unfortunately limited.

**Pathology of the testicles.** Both testicles were found to be the seat of a soft cellular type of growth (Fig. 10) and were about twice the normal size. The growths were homogeneous and vascular and had infiltrated the atrophic testicular substance and the epididymis. The outline was irregular and careful examination revealed several outlying foci of varying sizes apparently separated completely from the main mass. There were several small areas of hemorrhage but no cystic change or central degenera-

tion. The appearance and consistency of the tumors suggested a rapidly growing sarcoma. The cord was free contained no neoplastic extension and no nodules. The tunica albuginea was thickened and the tunica vaginalis on both sides had obviously contained fluid. On the right side there were numerous adhesions between the two layers of the tunica and some of the loculi thus formed contained blood clot probably the result of the exploratory puncture.

Microscopically the tumors were identical and were composed of small cells of lymphocytic type set in an irregular refringent reticulum (see Fig. 11). These cells had little cytoplasm but active hyperchromatic nuclei with occasional mitotic figures. They were seen infiltrating between atrophic tubules and at the edge were mixed with cells derived from disintegration of such tubules. Around the main tumor mass were multiple foci of similar cells and in some cases these appeared to be arranged around small blood vessels. Careful search for heterotypic tissues was made throughout the greater part of one of the tumors with negative results.

The cutaneous nodules were soft and extremely vascular and had infiltrated the subcutaneous fat widely and caused pressure necrosis of the epithelium. The latter however did not seem to be infiltrated a fact which is in keeping with the general sarcomatous appearances of the nodules. On microscopic examination they revealed an irregular infiltration of the subcutaneous tissues with a small lymphocytic type of cell similar to those of the testicular tumor.

**Nature of the tumor.** Two explanations of the nature of this neoplasm are possible. (a) that it is a bilateral primary sarcoma derived

from the connective tissue elements of the testicle with secondary cutaneous metastases and (b) that both the testicular and cutaneous tumors are metastatic and secondary to some other primary source.

In view of the small amount of lymphatic tissue in the testis the peculiar origin of the tumors from several centers, the rarity of any other form of bilateral neoplasm and the peculiar distribution of the cutaneous deposits it is difficult to accept the first explanation and it has been discarded by the majority of writers.

In the cases recorded by Chevasu (8) and Monod and Ferillon (34) generalized enlargement of the abdominal lymphatic gland was present and as pointed out by Chevasu it is possible that a retrograde lymphatic spread of the neoplastic process from the retroperitoneal lymph gland may be the explanation of the bilateral testicular involvement. It may be that the abdominal lymphatic gland are the seat of a lymphosarcoma which metastasizes in this peculiar manner. Some of the French observers and more recently Cumtson (10) consider that the condition allied to an aleucemic lymphatic enlargement there being as a rule no coincident alteration in the nature or number of the leucocyte in the blood. Another suggestion is that the condition is a form of Hodgkin's sarcoma with a somewhat peculiar distribution of metastasis. All observers are agreed upon the frequency of lymphatic glandular enlargement and of the fatal nature of the disease. Only by careful exhaustive postmortem examination will the true nature of the lesion be elucidated. From the somewhat meager knowledge at our disposal it seems to me that both the testicular and cutaneous nodules must be regarded as part of a general lymphocytic deposition in which they are metastatic.

#### TUMORS ARISING FROM THE INTERSTITIAL CELLS

The function of the interstitial cell is apparently to supply an internal secretion which determines the development of secondary sexual characteristics. Various observers have described tumor formation from these cells but the exact nature of these cases has

not yet been determined. Waldeyer (48) named one specimen plexiform angiosarcoma while Hansemann (21) suggested that certain of the alveolar sarcomata and carcinomata had a similar origin. In atrophic testes in which the seminiferous tubules have undergone degeneration or disintegration there is often an apparent hypertrophy of the interstitial cell and at times an appearance of overgrowth.

Thalud Durck (15) reported five cases in atrophic testicles both descended and undescended in which multiple hyperplasia of the interstitial cell had occurred. He was however uncertain whether the condition should be regarded as neoplastic or as a simple hyperplasia.

A comparatively large tumor measuring 9 centimeter by 12 centimeter and composed of polyhedral cells with active nuclei and irregular mitotic figures was described by Kaufmann (4). The type of cell present and their staining reaction led him to regard it as a sarcoma although he was somewhat guarded as to its malignancy.

Chevasu (7) also described a similar tumor about the size of a hen's egg which was reddish yellow in color on section. The cells composing it were large with abundant cytoplasm contained pigment and vacuoles had small active nuclei and were apparently identical with the interstitial cell. He thought the tumor was benign. No one has as yet observed any metastatic tumor of this type and none of the recorded cases can definitely be proved to be sarcomata. It is important however to bear in mind the possibility in of malignant tumors from this source especially in atrophic testes and it may be that some of the typical homogeneous tumors will be proved to be derived from the interstitial cell.

#### SARCOMATA DERIVED FROM THE FOLLICLES FOLLICULAR STRUCTURES THE TUNICA VAGINALIS THE EPIDIDYMIS AND THE SPERMATIC CORD

The interstitial tumors are comparatively rare and therefore most of them are reported so that Hinman and Gibson (22) were able to collect a great variety of cases from the literature. The writers deal with the subject very fully and give an exhaustive bibliography.

*Sarcoma of the tunica vaginalis* Hinman and Gibson were able to collect 1 case which could be regarded as authentic sarcoma of the tunica. The cases of Home (4) and Craven (9) described by Curling (11) are the earliest recorded. The greatest difficulty is in differentiating these from tumors of the underlying organ. Apart from their rarity they are of no special interest as they behave in a typical manner as regards course and metastasis.

*Sarcoma of the epididymis* As confusion has existed in the description of tumors of this region it is not surprising that sarcoma is the most commonly recorded. However the diagnosis of sarcoma must be accepted with reserve and an attempt made to correlate the descriptions given with modern pathological conceptions. The majority of purely epididymal tumors are probably carcinomata. Interesting cases which appear to fulfil the sarcomatous criteria have however been recorded among others by Curling (11) Edwards (16) Russell and Wood (4) Kolster (8) Grossman (20) and Miyata (33).

*Sarcoma of the spermatic cord* A great number of sarcomata of various cellular types have been recorded in this region and seem to be second in frequency to the lipomata. There seems no doubt that some of the recurrent lipomata of this region are very closely allied to liposarcomata. Series of case have been recorded by Gasano (19) Celso (6) Tidnat and Martin (46) Patel and Chaher (38) while Hinman and Gibson (2) have fully reviewed the reported cases. Fibrosarcomata and liposarcomata are the most common types and it seems that many of these have origin in a benign tumor which has been growing slowly over a long period. The possibility that some of these tumors are of a teratogenous nature has been emphasized by Kolisko (7) and Iwing (18).

Sarcomata arising from the peritesticular connective tissues are rarer although cases have been recorded by Miyata (33) Rokitsky (41) and Neumann (35). The latter have noted the presence of giant cells in these tumors and suggest the possibility of a myogenous origin from the upper part of the gubernaculum testis.

The following case history is that of a sarcoma of the retrotesticular tissues and I believe it to be of myogenous nature.

CASE 4. M. N. aged 17 years stated that about 3 years before admission to the hospital he had been struck on the left testicle by a cricket ball but that apart from the severe pain at the time he had had no ill effects. Two and a half years later he noticed a small lump behind and below the left testicle. This was quite painless but enlarged steadily. He had no other symptoms and appeared to be in perfect health. On examination a hard non-tender egg-shaped tumor was present below and behind what appeared to be a normal testicle. The epididymus could not be differentiated by palpation and it was thought that the tumor was a primary growth of that organ. The cord was normal. Rectal examination was negative and the contents of the other side of the scrotum appeared normal. The Wassermann reaction was negative.

Simple orchidectomy with high division of the cord was performed and the patient was still alive and well 3 years after the operation.

*Pathology* When the tissue removed was examined it was found that the tumor was independent of the testis, epididymis and cord. It was fairly well encapsulated homogeneous of a firm consistency and measured 7.5 centimeters by 4.5 centimeters in its longest diameters. It was pale pink in color and the cut surface resembled that of a fibrosarcoma. There were no areas of hemorrhage, cystic degeneration or softening. The colored plate (Fig. 13 frontispiece) gives its relations and approximate size. Below it tended to merge into the gubernaculum testis.

Microscopical examination of the whole of one half of the tumor was carried out by cutting serial sections. It was found to be composed in the main of fibroblastic spindle cells and conformed in all respects to the classical appearance of a spindle cell sarcoma of low malignancy (Fig. 14). The tumor was not very vascular but there was a tendency for the vascular channels to be represented by clumps with poorly developed walls rather than by definite vessels. In spite of careful search no trace of any teratogenous elements could be discovered. In one portion of the growth a few giant cells were discovered. These cells measured up to 25  $\mu$  in diameter and had four to six centrally arranged nuclei. They resembled those seen in myosarcomatous growths of the uterus and this suggests that this tumor is similar to that described by Neumann being in all probability derived from the gubernaculum testis.

#### SECONDARY SARCOMATA OF THE TESTICLE

Secondary sarcomata of the testicle are very rare and usually develop as the result of the carriage of metastatic emboli by the blood stream from a primary sarcoma elsewhere.



MECHANISM OF EMPTYING OF THE GALL BLADDER AND COMMON DUCT<sup>1</sup>

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AND

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S g l Sch l t th Asoc t f S g t G t B t d I l d

IN previous publications although admitting the possibility of intrinsic muscular contractions of the gall bladder we have questioned the position taken by many that these contractions constitute the only mechanism of emptying. Thus we have stated (4) Though the gall bladder has an elastic or contractile mechanism which exerts pressure on its contents until it has reached a minimum pressure we have not been able to demonstrate an actively contracting movement due to its intrinsic musculature and again in a later article (6) In the light of the new evidence we feel that perhaps we have not assigned sufficient importance to the factor of intrinsic contraction of the muscle and that this factor should be added to the physical forces mentioned responsible for the emptying of the gall bladder but we are unwilling to ascribe to muscular contractions the exclusive role in this drama. The observations of Boyden (5) and of Whitaker (7) that the gall bladder is frequently found collapsed after a meal of egg yolk or fat have shed further light on the emptying mechanism.

In a re investigation of this problem we have made use of the roentgenological method adopted by Whitaker (8) for experimental animals. The gall bladder is filled with iodized oil (iodopin) by open laparotomy and on the following day after recovery of the animal X ray films are made. Under these conditions it is found that if the animal is starved following the operation no emptying of the gall bladder occurs for 2, 3 or more days but the administration of a meal of fat or preferably of egg yolk and cream causes a flow of oil from the gall bladder into the duodenum. This emptying of the gall bladder commences within a short time after the administration of the meal and continues over a period of 3 or 4 hours. In some cases in the cat the gall bladder is completely empty by this time more

frequently traces of iodopin remain and these traces may then persist until another meal is ingested (Fig. 1).

As a result of such observations Whitaker has concluded. The emptying of the gall bladder is produced primarily by the action of its muscular tunic extrinsic mechanical factors having no appreciable effect (9). Burget (3) however does not concur with this conclusion. He states. Although following such procedure there is a noticeable reduction in size to deduce from this evidence that the gall bladder expels bile by forcibly contracting would seem unwarranted in view of its great elasticity.

To exclude the effect of elasticity of the gall bladder and the other mechanical factors which have been suggested to account for its emptying the following experiment was performed. The gall bladder of a cat was filled with iodopin and a cannula was inserted in the cystic duct pointing upward toward the gall bladder. The cannula was attached to a thin rubber bag made from a finger cot which was placed in the abdomen. The following day a meal of egg and cream was administered by stomach tube and roentgenograms were made immediately after the meal and 5 hours later (Fig. 2). At the time of the first roentgenogram 4 hours after operation all the iodopin was still in the gall bladder although the elasticity of the wall and the changes in the intra abdominal pressure had had every opportunity to function. Five hours after the egg meal a considerable degree of emptying of oil from the gall bladder into the rubber bag had taken place. It would seem from this experiment that the discharge of bile from the gall bladder is not necessarily dependent upon elasticity or extrinsic factors and may be the result of muscular activity.

Doubtless however muscular activity is not the sole agent normally engaged in the





Fig. 4. Dog. Gall bladder. (1) Flushing out by the flow and ebb of fresh bile from the liver and (2) elastic recoil of the distended viscus. The question of flushing out of the gall bladder by bile from the liver has been considered in a previous paper (4). It was shown by cholecystography that a rubber bag substituted for the gall bladder of a dog will fill and empty somewhat after the manner of the normal viscus. Further evidence of the importance of this factor is offered by the following experiment. In a dog the hepatic ducts were ligated above the entrance of the cystic duct and the gall bladder was filled with lipiodol. Complete emptying had not occurred at the end of 30 days although during this time the dog was fed egg yolk and cream in addition to regular diet. This result indicates that the ebb and flow of bile from the liver is a factor of some importance in the emptying of the gall bladder.

Fig. 5. Monkey. Gall bladder. (1) Flushing out by bile of the special importance for in the case it is difficult to see how even vigorous contraction of the wall could completely empty the gall bladder. In the monkey (macaca rhesus) in which the anatomical arrangement is the rule complete emptying of the gall bladder may be delayed for a long time even if meal of egg yolk and cream are administered (Fig. 6).

In many animals the anatomical arrangement of the gall bladder which may be closely attached to a large area of liver or even completely embedded in it renders the flushing out by bile of special importance for in the case it is difficult to see how even vigorous contraction of the wall could completely empty the gall bladder. In the monkey (*macaca rhesus*) in which the anatomical arrangement is the rule complete emptying of the gall bladder may be delayed for a long time even if meal of egg yolk and cream are administered (Fig. 6).

It is difficult to determine whether the muscular activity of the gall bladder is of the nature of a true peristaltic action or of a change in tone. Change in size and shape of the gall bladder is seen on X-ray films have been taken to indicate the presence of peristaltic action but such evidence is not conclusive since similar changes in shape may result from other causes such as the pressure of other viscera. This point is demonstrated by Figure 4 which shows a cat in the abdomen of which



Fig. 3. Upper picture gall bladder of monkey filled with iodized oil 4 hour after operation before evening meal. Lower picture 7 day later after several evening meals very little emptying has taken place.

was placed a rubber bag partly filled with iodopin. Changes in shape are seen which are of course entirely due to variations of pressure from adjacent viscera. These changes might easily be misinterpreted as being due to peristalsis.

This pressure of adjacent organs (that is the intra abdominal pressure) has been adduced by many investigators to explain the emptying of the gall bladder as well as its change of shape. Apparently however it plays a very minor role. In the experiment previously described in which the cystic duct of a cat was catheterized by a glass cannula leading to an intraperitoneal rubber bag vigorous struggling due to the passage of a stomach tube failed to express a single drop of iodopin from the gall bladder (Fig. 2). Further investigations of the importance of this factor point to the same conclusion. In a dog a cannula leading to a rubber bag was inserted into the common duct and the wound



Fig. 4. Abdomen of cat with rubber bag filled with iodized oil. Note the changes of configuration suggestive of peristaltic waves.

tightly closed around a rubber tube. The intra abdominal pressure was then alternately raised and lowered by passing air through the tube into the abdominal cavity the pressure varying from 0 to 60 centimeters of water. After half an hour of such variations in the pressure the bag was examined and found to contain merely a few drops of bile expressed from the ducts; the gall bladder remained full.

As it was felt that objection might be raised to this experiment because of the presence of air in the peritoneal cavity, a further experiment was performed in which variations of pressure were induced comparable to those occurring normally. In this case in a dog the common duct was intubated with a cannula and the abdominal pressure was then raised periodically to simulate respiration by the forced insufflation of air into the trachea counter pressure being applied to the abdominal wall by means of a tight binder. Consider



ter is opened a spurt of bile is seen to follow each contraction.

We have attempted to show in the cat movements of the common duct by an indirect method. The common duct was filled with iodopin and all the hepatic ducts and the cystic duct were ligated to prevent its being washed out by fresh bile. Roentgenograms taken at intervals showed that the common duct emptied during a period of 1 hour. This seems to indicate active movements of the common duct but other factors such as the action of the duodenum may be present.

#### ABSORPTION FROM THE GALL BLADDER

In searching for an alternative opaque material to iodized oil for experimental use we found that sodium iodide rapidly disappears after injection into the gall bladder. This rapid disappearance at first believed to result from emptying from the gall bladder proved to be due to its absorption through the gall bladder wall and occurred just as rapidly after ligation of the cystic duct. Chemical tests showed the complete disappearance of the sodium iodide from the gall bladder within a few hours. Subsequent roentgenograms showed its presence in the urinary bladder (Fig. 5). The process is probably a physical one not dependent upon a specific property of absorption by the gall bladder wall. The disappearance of the sodium iodide from the gall bladder after ligation of the cystic duct was not hastened by the administration of a fat meal.

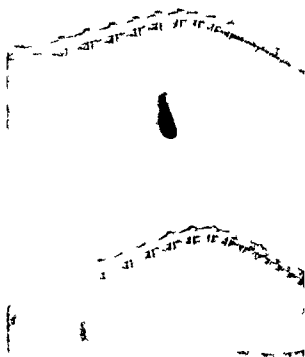
#### CONCLUSIONS

The emptying mechanism of the gall bladder is dependent partly upon an intrinsic mus-

cular action partly upon its elasticity and partly upon the ebb and flow of fresh bile from the liver. The latter factor is of especial importance in animals in which the anatomical arrangement of the gall bladder precludes its complete contraction as in the monkey. Variation of intra-abdominal pressure plays a minor role in the emptying of the gall bladder. Peristaltic contractions of the common duct have been observed in pigeons and it is suggested that they may take part in the flow of bile in some mammalia. The response of the gall bladder to a fat meal depends upon its absorption through the intestinal wall. It is not proved whether the response of the gall bladder is due to hormone action or nervous excitation. Sodium iodide is absorbed by the gall bladder wall.

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able changes in intra abdominal pressure such as coughing caused no change in the size of the shadow of the gall bladder and even when the cannula was led outside of the abdomen only a few drops of bile the actual duct content were expelled. It would seem therefore that the intra abdominal pressure plays a very small part in the emptying mechanism of the gall bladder.

#### NATURE OF THE RESPONSES OF THE GALL BLADDER TO THE EGG MEAL

The observation of Sosman ( ) that the gall bladder emptied normally in a patient who had had a resection of the pylorus and gastrojejunotomy suggests that the response does not depend upon local stimulation of the mucous membrane of the duodenum. Whitaker claims that the emptying of the gall bladder is independent of the flow of pancreatic juice but we have not confirmed this latter finding. We excluded pancreatic juice from the duode-

num by separating the pancreas from the duodenum and by ligating the pancreatic ducts in 3 cats and 1 dog and in these animals no emptying of the gall bladder occurred after successive meals of egg and cream.

There is some evidence that the gall bladder is influenced by certain internal secretions such as in feline as adrenalin but the interpretation of this action is not quite clear for after complete removal of both suprarenals the gall bladder empties normally in response to a fat meal in observation made by Boyden and confirmed by us. In a further investigation of a possible hormonal action we have injected intravenously secretin insulin pancreatic juice and alcoholic and acid extracts of cow and dog gall bladder all of which injections had no effect on the size of the gall bladder. Nor did the direct injection of egg yolk into the gall bladder accelerate its emptying.

#### COMMON DUCT

The common duct is generally looked upon as merely a passive channel and indeed its thin wall and the paucity of muscular fibers lend support to this belief. Nor has any spontaneous movement of the common duct been observed in man or other mammals. Comparative and experimental studies suggest that it may have a more important rôle for in many fowls the common duct exhibits well marked muscular contractions. The contractions are easily seen in the pigeon and other birds as has been observed by Doyen (5) and others. To observe these contractions in the pigeon the abdomen is opened under ether anesthesia and access obtained by removing the lower part of the sternum. Active movements of the common duct are then readily visible. They occur quite frequently some times every 5 or 10 seconds and are of true peristaltic nature a wide relaxation phase preceding the contraction and extending rapidly from the portal fissure down to the papilla of Vater. As the duct is thin walled it is easy to see dark bile accumulating at the upper end of the duct and then rapidly being propelled down into the intestine. If the lat-

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ter is opened a spurt of bile is seen to follow each contraction

We have attempted to show in the cat movements of the common duct by an indirect method. The common duct was filled with iodopin and all the hepatic ducts and the cystic duct were ligated to prevent its being washed out by fresh bile. Roentgenograms taken at intervals showed that the common duct emptied during a period of 12 hours. This seems to indicate active movements of the common duct but other factors such as the action of the duodenum may be present

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#### CONCLUSIONS

The emptying mechanism of the gall bladder is dependent partly upon an intrinsic mus-

cular action partly upon its elasticity and partly upon the ebb and flow of fresh bile from the liver. The last factor is of especial importance in animals in which the anatomical arrangement of the gall bladder precludes its complete contraction as in the monkey. Variations of intra abdominal pressure play a minor role in the emptying of the gall bladder. Peristaltic contractions of the common duct have been observed in pigeons and it is suggested that they may take part in the flow of bile in some mammalia. The response of the gall bladder to a fat meal depends upon its absorption through the intestinal wall. It is not proved whether the response of the gall bladder is due to hormone action or nervous excitation. Sodium iodide is absorbed by the gall bladder wall.

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# GALL-BLADDER FUNCTION AFTER DIVISION OF THE COMMON DUCT AND TRANSPLANTATION OF THE PROXIMAL SEGMENT

WITH A HISTOLOGICAL STUDY OF THE REPAIR AT THE SITE OF TRANSPLANTATION<sup>1</sup>

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F m h D p m t f i h i g y d s g y C l l g f i h y d s C i m b t t

ACCORDING to the law of contrary innervation promulgated by Meltzer (7) bile storage and bile discharge are controlled by a mechanism of reciprocal reflexes between the gall bladder and the sphincter of Oddi. The observations of Lotter and Mann (8) and McMaster and Elman (6) supported this view. On the other hand Burget (2) and Copher and Kodama (3) minimized the importance of the action of the intramural segment of the common duct and emphasized the role of the duodenal musculature in the control of the flow of bile into the intestine.

In order to determine experimentally whether the sphincter is essential for normal gall bladder function, complete exclusion of the sphincter and complete severance of its neuromuscular continuity with the gall bladder must be insured. In addition a reliable method of observing the action of the gall bladder under relatively normal conditions is necessary. A consideration of these factors suggested the procedure which was employed in the following experiment.

The common duct was divided extramurally and the proximal segment was transplanted to another part of the duodenum. This allowed the duodenal musculature to act directly upon the wall of the duct (which was practically free of intrinsic smooth muscle fibers); the sphincter was eliminated and the neuromuscular connection with the gall bladder was severed. In order to insure firm union at the site of the transplantation a number of weeks were allowed to elapse. Then the function of the gall bladder was determined by means of serial cholecystograms made according to the method described by Graham Cole and Copher (5). This method was chosen because it permitted frequent observations of the filling and emptying of the gall bladder under normal conditions.

## TECHNIQUE

Under ether anesthesia and with a eptic precautions the common duct in dogs was isolated and doubly ligated just above its entrance into the duodenum. A linear incision 2 centimeters long was made in the anterior surface of the duodenum 6 centimeters and 8 centimeters respectively from the pyloric sphincter. The duct was divided  $\frac{1}{2}$  centimeter proximal to the ligature and the free end was fixed at the lower angle of the opening in the duodenum which was then closed by 2 inversion suture. Silk was used throughout.

Cholecystograms were obtained in the following manner: 0.12 grams of sodium tetraiodophthalein per kilo bodyweight was injected intravenously. Eighteen hours after the injection of the dye the first X-ray film was taken. Then the dogs were fed with the yolks of 3 eggs in 200 cubic centimeter of cream (1) and films were taken at intervals of 1, 3, 6 and 24 hours after the meal.

## EXPERIMENTAL RESULTS

Dog 8715 Male Weight 15.4 kilos. Operation October 21, 1926. The proximal stump of the divided common duct was implanted into the duodenum 6 centimeters from the pyloric sphincter. The pictures of the first series of cholecystograms were taken December 14, 1926, 54 days after operation. The gall bladder shadow was normal in size and density at the 18 hour observation. Following the feeding of the egg yolk and cream mixture there was a progressive diminution in the density of the shadow but only a slight decrease in size at the 1, 3 and 6 hour periods. After 24 hours the shadow was still present.

A second series of X-rays was taken April 1, 1927, 119 days after the first series. The gall bladder shadow was of normal size and density at the 18 hour period. After the meal however the results differed from those obtained at the previous examination. At this observation there was a progressive decrease in the size of the shadow with an increase in the density at the 1 and 3 hour periods. At 6 hours the shadow was about the same as at 3 hours.



Fig. 1. Gross appearance of the gall bladder and bile ducts of Dog 8715 15 days after the transplantation of the proximal segment of the divided common duct. X indicates the site of the ligated sphincter of Oddi and T the site of the transplantation. Half size.

After 4 hours it had disappeared completely (Fig. 3).

The dog was in excellent condition and was killed with ether on April 14, 1927, 175 days after operation. The gross appearance of the gall bladder and bile ducts at autopsy is shown in Figure 1. The size and shape of the gall bladder corresponded closely to the cholecystograms; it was filled with dark green viscid bile which was sterile upon culture. The cystic duct was normal. The common duct and the main hepatic ducts were dilated. The intramural segment of the transplanted duct was patent. The site of the choledochoduodenostomy was 4 centimeters from the pyloric sphincter; this was closer to the pylorus than at the original transplantation due probably to retraction of the duct during the process of healing. A few thin omental adhesions surrounded the lower end of the duct. The old distal stump of the divided common duct was recognized by a small nodule on the posterior surface of the duodenum (indicated by X in Fig. 1).

Dog 8716. Male. Weight 11 kilos. Operation, October 25, 1926. The proximal end of the divided duct was implanted into the duodenum 8 centimeters from the pyloric sphincter. The first series of cholecystograms which was taken December 7, 1926, 43 days after operation, showed a gall bladder shadow of normal outline and density at the 18-hour observation. After the feeding of egg yolk and cream the following changes occurred: at 1 hour the shadow was smaller and more dense; at 3 hours it had returned to its original size; at 6 hours there was again a definite diminution in size with increased

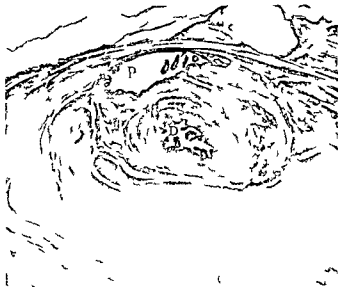


Fig. 6. Dog 8715. Transplanted duct in the muscularis of the duodenum. Due to the tortuous course of the duct the proximal P and the distal D end appear in the same section. X15.

density. After 4 hours the shadow had disappeared (Fig. 6). At the time of this cholecystography the dog was in good condition but subsequently it lost weight.

A second series of films which were taken March 11, 1927 (94 days after the first series) did not disclose a gall bladder shadow. Additional series were taken March 18 and March 20 with the same negative results. The dog was killed with ether on April 9, 1927, 166 days after operation. At autopsy numerous adhesions were found at the site of the transplantation which was 6 centimeters from the pylorus. One of the adhesions extended over the cystic duct and occluded its lumen. The gall bladder contained a small amount of thick inspissated bile; its wall was thickened. The common duct was slightly dilated. The intramural portion of the duct was patent. The site of the original occluded sphincter was identified.

In both dog microscopic examination of the liver, gall bladder, hepatic and smaller bile ducts, and pancreas revealed no abnormalities. The epithelium of the common duct was flattened.

## RESULTS

In order to interpret properly the cholecystograms which were obtained after division and transplantation of the extramural segment of the bile duct they were compared with the gall bladder shadows obtained from 2 normal dogs under the same conditions the same technique being used. In the first dog a normal cholecystogram was secured and the feeding of egg yolk and cream caused a progressive diminution in the size of the





f t f t f t f D S s d y  
A S l ft  
B C l D z d o  
l r s p t ly ft f l k v lk d m  
t f f ft f d g ml t d

II f l d



FIG. 4 (left) Dog 8715. At the opening of the transplanted duct in the duodenum. The muscularis of the duodenum *M* surround the base of the bile duct *B* which has a small protrusion into the lumen of the intestine.  $\times 15$ .

FIG. 5 Dog 8715. Transition from bile duct epithelium *B* to intestinal epithelium characterized by goblet cells *G*. Taken from the area included in the rectangle in Figure 3.  $\times 25$ .

shadow with an increase in density at the 1 and 3 hour observations. At 6 hours the shadow was the same size as at 3 hours but less dense. After 4 hours it could be outlined faintly. In the second dog feeding caused no perceptible change in the size of the shadow but its density was decreased in the 1 and 3 hour films. At 6 hours the cholecystogram was practically the same as the original one. At the end of 24 hours a definite shadow was still present. These observations indicated the variations that occurred in the cholecystograms of normal dogs following an egg yolk and cream meal. Similar variations were observed by Graham (4) in dogs and by Whitaker and Boyden (9) in man.

A comparison of the roentgen appearance of the gall bladder in the experimental dogs with that of the normal dogs showed that the experimental results were well within the limits of normal variations.

The persistent absence of a gall bladder shadow in dog 8716 in the second series of roentgenograms was explained at the autopsy by the discovery of an adhesion which occluded the lumen of the cystic duct. This oc-

curred subsequent to the earlier series in which the filling and emptying of the gall bladder were normal.

#### STUDY OF THE REPAIR

Although choledochoduodenostomy has been performed successfully in man and in dogs little is known about the nature of the repair at the site of the transplantation. The 2 dogs which were used in the preceding experiment afforded the opportunity to make a detailed histological study of the intramural portion of the transplanted duct and the process of healing.

The segment of the duodenum which contained the transplanted duct was removed immediately after death and fixed in Zenker's fluid. Then the specimen was embedded in paraffin and serial cross sections were made and stained with hematoxylin-eosin and by Van Gieson's method.

The character of the repair was essentially the same in both dogs. Due to the fact that the duct penetrated the duodenal musculature in an irregular S-shaped manner two lumina appeared in some of the sections. *P*



mation of villi. Normally the latter are not found in the mucosa of the extramural segment of the common bile duct. The union between the duct epithelium and the intestinal epithelium occurred at the orifice of the duct without any interruption in the continuity of the mucosa.

After prolonged ligation and disuse the structure of the original sphincter remained unaltered.

#### SUMMARY

1. After complete division of the common duct and transplantation of the proximal segment, relatively normal cholecystograms were obtained in dogs.

A specialized neuromuscular relationship between the gall bladder and the sphincter of Oddi was excluded.

3. A study of the repair at the site of the transplantation was made.

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CONGENITAL ARTERIOVENOUS COMMUNICATIONS<sup>1</sup>

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**A**BNORMAL communications between arteries and veins may be divided into two groups: congenital and acquired. The latter are the result of trauma, often in the form of stab and bullet wound, and form the majority of such conditions. The former are rare and therefore all the more interesting; there is no history of trauma, but they manifest themselves at birth or at a varying time afterward and run a progressive course. Callander in 1906 published a comprehensive review of the literature on arteriovenous fistula, collecting records in all of 447 cases, beginning with that described by William Hunter in 1757. He found that 383 of the cases were due to trauma, that in 34 the etiology was unknown, and that the remaining 30 were of congenital origin, these being reported by Bushe, Hewett, and Halsted. One realizes of course that cases of the congenital type are probably not so rare as the paucity of the number of recorded cases would lead one to suspect; many no doubt having escaped report in the literature. Callander's review shows well the preponderance of cases of the acquired type usually found.

Bushe's patient was a girl aged 3 years and 7 months, presenting a purple pulsating tumor about 1 centimeter by 1 centimeter in the region of the right temple. The tumor had existed and gradually enlarged from birth, and for the 3 months prior to examination had been attended by hemorrhage. While pressure was being made on the carotid vessel, Bushe removed the tumor with a few quickly executed sweeps of a scalpel. With pressure on the carotid released almost the whole of the raw surface spouted blood, the hemorrhage being controlled at first by the actual cautery, though eventually ligation of the external carotid was necessary.

In the case reported by Hewett, the patient was a girl aged 17 years, whose right thigh

from birth had been larger than the left. As long as the patient could remember she had had a peculiar beating in the affected limb. At first the swelling was confined to the thigh, spreading later to the leg and finally involving the foot. The report says that hydrocephalus was present in infancy (evidence of a concomitant congenital anomaly). Examination showed the right lower extremity much enlarged and 5 centimeters longer than the left; the superficial veins were large and tortuous, although quite soft and easily emptied of their contents. In the enlarged femoral vein a distinct vibratory thrill could be felt and traced upward to the juncture of the two iliac veins, where it ceased. A loud continuous blowing sound could be traced up the vein to the same spot. There was a loud systolic murmur at the apex of the heart, but the size of the organ was not mentioned. Hewett's treatment consisted in placing harelip pins under all the veins he could see and compress the vessel by twisted suture placed under the pins, which were allowed to remain in place 5 days. The treatment was not successful and the patient was dismissed *in statu quo*. Hewett believed that an arteriovenous communication existed on the right side between the common iliac vessels at their point of crossing.

Halsted's case of much more recent date was a girl aged 11 years with a throbbing swelling in the right side of the neck. A throbbing and buzzing were discovered 3 days after birth, but an actual swelling was not observed until the ninth year. At operation a fistula was found between the external carotid near its origin and one of a mass of greatly dilated vein. Great dilatation of both common and external carotid arteries was noted, whereas the internal carotid was surprisingly small. The heart was normal and even in rhythm. At the time of a second

operation 6½ years later there were no signs or symptoms of cardiac involvement

The most recent cases of congenital arteriovenous fistula were reported by Reid (16) a former pupil of Halsted. There are 6 in all including that of Halsted. Reid having had occasion to perform an operation on the patient 6½ years after his former teacher. The situations of the lesions in the 5 new cases were as follows: the left lower eyelid, the right subclavian and transversalis colli vessels, the left anterior tibial vessels, the right cerebral vessels and between the internal carotid artery and the cavernous sinus. Thus 4 were in the head and neck and 1 in an extremity.

We are reporting here 9 additional cases of congenital abnormal communications between arteries and veins which have been seen at the Mayo Clinic since 1916. We were able to carry out detailed clinical studies in Cases 3, 5 and 8.

#### REPORT OF NEW CASES

**CASE 1.** A girl aged 23 years had been troubled since birth by a bunch of bluish dilated veins over the right occipital and temporal regions. Trauma apparently aggravated the congenital condition for after the age of 10 years when she was struck by a stone near the dilated veins these began to enlarge and the dilatation gradually extended downward into the neck.

A large mass evidently of pulsating veins was seen over the right lateral aspect of the head and the right side of the neck (Figs 1 and 2). There was a loud bruit audible throughout the mass and a marked thrill just in front of the ear. The systolic blood pressure was 116 and the diastolic 90; the pulse rate was 84. A systolic murmur was heard at the apex of the heart but there was no enlargement of the organ.

The first operation was performed August 3, 1916. Arteriovenous anastomosis was found on the right side of the neck and on the scalp extending to the median line in the parietal and occipital regions. Distinct pulsation was evident throughout the entire mass. The largest vein in the neck was apparently the external jugular which extended down over the sternum and reached the median line. This vein was about 5 centimeters in diameter. Ligation of the external carotid stopped pulsation in the entire mass. The veins of the neck were excised.

At a second operation August 11 the incision was carried from the front of the ear up to the median line and over the occiput; a flap was turned back and carotid vessels dissected out. Some of the vessels were ruptured during the operation and a great deal of hæmorrhage ensued. A slight amount of pulsation



Fig. 1 (left) Dilated veins of right side of head and neck (Case 1)

Fig. 2 Head shaved showing mass of dilated veins in scalp (Case 1)

was observed in the vessels at this operation. The patient recovered from the operations but died about ¼ months later from bilateral pulmonary emphysema and bronchopneumonia.

**CASE 2.** A girl aged 10 years complained of prominence of the eyes. Nothing abnormal had been noticed until she was about 4 years of age when the right eye appeared more prominent than the left. This prominence had become more noticeable as time went on.

There was some degree of exophthalmos of the right eye; large subcutaneous dilated veins were visible above the inner canthus and the medial half of the eyebrow. The eye could be pushed back ¼ inch into the orbit and the swelling about the medial part of the eye could be easily reduced by pressure. A typical arteriovenous thrill and murmur could be felt and heard over the veins. The systolic blood pressure was 115 and the diastolic 74; the heart was normal.

At operation February 12, 1918 the right external carotid artery was ligated. The exophthalmos pulse and thrill disappeared and the patient has had further trouble.

**CASE 3.** A man aged 20 years had been born with the right arm larger than its fellow (Fig. 3). The condition did not cause symptoms until he was 11 years of age when he began to have spells during which the arm became swollen and painful with accompanying general malaise. After the second spell the wrist and fingers became ankylosed and suppurative of the middle finger ensued. The patient first came to the Mayo Clinic in 1919 when the right arm was seen to be of greater girth than the left also exceeding it in length by 1.25 centimeters. A pronounced arteriovenous bruit was heard in the palm and also in the clavicular region of the right side. Roentgenogram of the hand showed destructive arthritis of the proximal ends of the metacarpal bones.



TABLE II—SURFACE TEMPERATURES OF UPPER  
EXTREMITIES IN CASE 5 MAY 17 19 5  
ROOM TEMPERATURE 23.8 DEGREES C

A	Temp h. ght	C Left
Tip of third fin cr	30.9	30.8
Tip of thumb	31	31.0
Knuckles	31.5	30.1
Distal of wrist	31.65	29.8
5 cm above wrist	31.7	30.5
15 cm above wrist	33.3	30.5
10 cm below elbow	33.5	31.0
5 cm above elbow	32.7	31.8
15 cm above elbow	33.3	31.5
10 cm below shoulder	33.3	32.3

There was atrophy and gangrene of the distal phalanx of the little finger. An arteriovenous aneurism of the right ulnar artery and vein just distal to the annular ligament was excised and the artery proximal to the aneurism was seen to be enormously dilated its diameter being about 2.5 centimeters. The radial artery was exposed and found to communicate with a large vein in the anatomic snuffbox; both artery and vein were ligated. The ankylosed little finger was also amputated at this time. In 1923 ulceration of the index finger took place although there was no history of trauma and gangrene ensued. The patient returned and the finger was amputated. He became gradually worse and the right hand became a direct hindrance to him. In 1925 dry trophic ulceration appeared at the site of amputation of the index finger and on the middle finger.

Numerous large dilated tortuous and pulsating veins were seen on the forearm and dorsum of the right hand being more marked on the medial side (Fig. 4). A thrill was felt and bruit heard as far proximally as the middle of the arm. The right arm was 1.25 centimeters longer than the left and averaged between 4 and 5 centimeters more in circumference than the left. The systolic blood pressure was 120 and the diastolic 80. The pulse rate was 85. The heart was markedly enlarged, the apex downward and to the left and a marked systolic thrust was seen over the lower part of the præcordium. There was a systolic murmur over the base. No signs or symptoms of cardiac decompensation were present.

There was marked difference in the surface temperature of the two upper extremities (Table II) the right arm being the hotter.

Table I shows as in the previous case that the venous blood in the neighborhood of the arteriovenous communication contained so much oxygen as to be almost arterial.

Amputation was performed through the forearm. During the operation the bleeding from the numerous dilated veins was like that from arteries.

Dissection of the amputated part disclosed dilatation of both arteries and veins and multiple fistulae between them (Figs. 6 and 7). The condition is also well shown by roentgenographic examination after the injection of a solution opaque to roentgen rays.

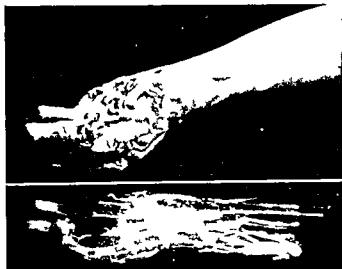


Fig. 4 (above) Dilated and tortuous vessels on dorsum of hand and forearm (Case 5)

Fig. 5 Amputated arm after injection of barium solution (Case 5)

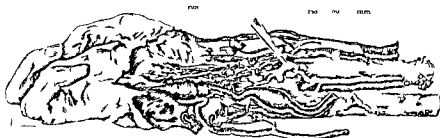
(Fig. 5) The solution returned almost immediately through the cut ends of the vessels and after it had congealed a roentgenogram was made. It is of interest to note that while the solution fills the dilated proximal arteries and veins the more distal vessels are only partially filled because of the short circuiting due to the fistulous communications.

Since the operation the local physician reports that the patient's condition is excellent.

CASE 6 A man aged 24 years came to the Mayo Clinic in 1912. Ever since he could remember his right foot had been larger than the left. In 1909 an ingrowing great toe nail of the right foot was operated on; it became infected and for 4 years constantly drained pus, the toe eventually turning black. In 1913 there was a sudden hæmorrhage from the dorsum of the right foot near the metacarpophalangeal joints; the bleeding was stopped by binding the foot. The great toe was amputated in 1914 and since that time there had been several hæmorrhages. The patient had noticed that the right foot was much swollen and he felt pulsations in the foot, leg and thigh. An ulceration on the dorsum of the right foot still persisted. A year before the patient's admission to the Clinic the foot was operated on and the anterior and posterior tibial vessels were probably ligated.

All the superficial veins of the right leg were greatly dilated (Figs. 8 and 9). The great toe was absent and there were chronic ulcerations on the dorsum of the remaining toes. Thrills and bruits were present from Poupart's ligament distally as far as the toes. The right foot felt like a mass of spongy tissue. Pressure over the internal saphenous vein immediately caused the foot to swell. There was a loud blowing systolic apical murmur and the lesion of the heart was diagnosed as chronic mitral endocarditis with regurgitation (as the patient gave a history of previous rheumatic fever, the condition of the heart





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I 6 D t d p m l p t t t t s l d l t t f b l l l  
(th t t m (C ) )

could not be attributed to the a l e e f f c t s f the state of h leg) R entgenogram of the heart l i d n t h v largement The b n e s f the f o t c normal b y entgenogram The s v t o l i c b l l p r u e i s 130 a d t h d i a t o l c o the p u l e r a t e as 80

At the f r t o p e r t M a 4 9 t h t r t i b i l a r t e v l the v e i n n the d o r s u m of the f o t e e l g t d The a t e v j t p r m l t t h t r s e c r u r l l g m t a s l l a t l t o a l u m t e r of b u t 3 / c n t m e t e l t a l l m a k l y t h c r d The a r t e r e u s c o m m u t n c u l l n o t l l c t c d d e f i n i t e l y

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CASE 7 A o m a n a g e l 24 y e a r a m e t o the M a y o C l i n i J u a r 6 10 3 T w e n t y f i e m n t h s b e f e s h e h a d n o t e d l l n g o the c h t h s e l l i g h d g r a d u a l l y e l a g e l a d f o a l l h a d h a d a b l u h t g e h u c h d i s a p p e a r e d l a t e r T h r e h a l b e e n n a o c t d p a

The a s a p u l a t g i r e g u l a r t u m n the c h n t o the l e f t of the m e d i a n l i n e and e t e n d i n g d o

r d s o a t r o h n the s u b m e t l g i n T h e t u m o r m e a u d p p m t l y 5 b y 5 b y 5 t i m e t s I t a o f t l a l e f n i t e t h r i l l v a s p a l p a b l e The y s t o l c b l i p r e u r e a s 18 n d the d i a s t h c 8 t h e p l s e r a t e a 88 T h h t a s n o r m a l

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v h h l a s u p e r f i c i a l t t h a t o r l e l l y of the d g t m u l e a r e m o d e d T h e r e v a s a m d r a t e a m u n t f b l l g T h e p a t h o l o g i c a l p t h m n g o m a

The p a t i e n t r e t r e l M a y 9 6 t h s l i g h t f l l the r i g h t l f t h e c h i n a s l i g h t t h r i l l v a p e r c e p t i b l e K a l u m t a t m e t s d e d C A E 8 A g l a g e l 16 y e a r s c a m e t o the M a y o C l i n i t h a c t h c l i t f h e l f t o t e s t i g t e l l m o t h e r t a t e d t h a t f r m the t i m e the p t i e n t w a l a l a v t h l f t f t h d t s e e m e d q u i t e n r m l l h the c h i l d r e a c h e l t h e a g e of 8 y e a r s t h f t h a l c e m d t b h t t e t h a the o t h e r T h r e e e x l t m l l c b b e g a n t a p p e a r o n the d o u m f the t o e s g r a d u a l l y n r e a n g i n s i z e and a c c m p a n d l y a l c h a g f g e h p B e c a u of the p r e a d f t h u l c e r o u s a r e a the u t e r f u t e r e a m p u t a t d i n M e c h 9 4 T h e g l a s t l d a t t h t i m t h t h e a s u f f e r n g f m t u b e r l o s i s f the f o t O n a c c o n t of a s i m i l a r c o d i t n f the g r e a t t h i g d g t a s a m p u t a t e d the f l l g v m l e

A l l the t e f the l f t f o t h a l b e e n a m p u t e d the t u m p s o l l e l e y l a l n e a r the m e l i s i l e f t h l s t a l l a a c a b c c r e i s i n u s h h h i f t e l n c e the f r t o p e r a t ( T g r ) T h e f t a u n i l l h t l s t e i o t o the i n t r n a l m l l e l s a n e b u t 3 c e n t i m e t e r s d m e t e e h c h a l c t t h r i l l v n h o n o u t h t h p u l e a p a l p a b l e O t h d o r s u m f t h f o t a s i m i l a r t h r i l l c l l b e f e l t e a l a r g e a r e O n v a s c l t a t i o f the l u d c n t i n u b r u t t h e c e b t c p d g t the v t l e f t h h t a h e r d T h i b u t l t h o g h of m a x m a l n t e n i t y o e r t h e s e a r e a s c u l d b e h e a l s f a r p r o m a l l a s the m i d d l e f t h c l f T h l e g s e e e q u a l l e g t h T h e l e r t a v o t e l g l l t h e f t m t l s l a s a c c e t a d l l e v t l b l d p e o a n l the h a s t l s T h p u l a t a 8 R e t g e n o g r a p h i c e a m n t n f the f o t h l t l t a l l t h t e h d b e a m p u t a t e d t h r o u g h the m d i l e of the m a t a r a l b u t l s i n of the l e o t l c b l e

C a l o r m t r i c s t u d e s e e m a d e v l t h S t e a t K e g e r r i e s f o o t c a l m e t e r t o l e t e m i n e the h a t e m i s s i o n of b o t h f e e t ( T a b l e I I I )



Fig 7 Dorsal aspect of dissected specimen shown in Figure 6 (Case 5)

It will be seen that the left foot was emitting nearly 1 times as much heat as the right

Table IV shows that from the knees downward the temperature of the left leg became progressively higher than that of the right; the maximal difference was attained at the heel 5.2 degrees C (8.6 degrees F)

In this condition one would expect to find the oxygen content of the venous blood in the vicinity of the arteriovenous communication varying greatly from normal (Table I). Thus the venous blood from the affected (left) foot contained more than four times as much oxygen as that from the right and consisted of nearly pure arterial blood. The total volume of whole blood was found to be 106 cubic centimeters for each kilogram of body weight.

June 26 the dorsalis pedis and posterior tibial arteries in the left foot were ligated. In consequence of this procedure the foot appeared to improve for a short time. July 7 it was seen that the total volume of whole blood was 88 cubic centimeters for each kilogram of body weight; this was a marked decrease. After a few weeks the foot began to cause pain again and the scab covered sinus at the distal end of the foot did not show any signs of healing. The patient returned and the foot was amputated.

Pathologically this seems to be a case of multiple aneurismal varicose or cirroid aneurism.

TABLE III—CALORIMETRIC STUDIES OF BOTH FEET SHOWING THEIR MARKED DISSIMILARITY OF HEAT EMISSION CASE 8

Date	6-18-35
Blood Pressure	
Systolic	20
Diastolic	80
Pulse	80
Temperature (C)	
Outdoor	4
Room	3.8
Right foot	
Total calories for 10 minutes	680
Surface area (square inches)	9
Calories for each minute for each square inch	0.73
Left foot	
Total calories for 10 minutes	7100
Surface area (square inches)	8
Calories for each minute for each square inch	8.6

CASE 9 A boy aged 6 years was first seen in June 1921. He was quite well until the previous November when the parents noted slight puffiness of the left upper eyelid. Shortly afterward they noted pulsation in the region of the inner canthus and then a distinct bruit over different parts of the head.

The patient was well nourished. There was slight exophthalmos of the left eye with some congestion of the conjunctival blood vessels. Pulsation was visible and a bruit of maximal intensity over the left temporal area could be heard over the whole skull. Pressure on the left common carotid artery reduced both thrill and bruit considerably. The heart was normal. The systolic blood pressure was 108 and the diastolic 52; the pulse rate was 98. Examination of the fundus disclosed bilateral choked disc. At operation July 1 the left common carotid artery was ligated just below its bifurcation. In May 1923 there was no marked change in the patient's condition; the exophthalmos, pulsation and bruit still persisting.

The main points of interest in the nine cases are summarized in Table V.

#### ETIOLOGY

The studies of Sabin and Woollard appear to explain the occurrence of these arteriovenous communications on an embryological basis, since both arteries and veins arise through differentiation from a common capillary plexus. Sabin finds that in certain embryological vessels the direction of the flow of

TABLE IV—SURFACE TEMPERATURE OF FEET AND LEGS MEASURED AS FAR AS POSSIBLE OVER CORRESPONDING AREAS JUNE 17 1935 ROOM TEMPERATURE 23.8 DEGREES C

	A	Temperature (C)	
		Right	Left
Heel		5.6	30.8
Dorsum of foot		27.5	32.3
10 cm interval proximally			
	1	9	32
	2	29.3	31.9
	3	30.2	31.4
	4	30.5	31.8

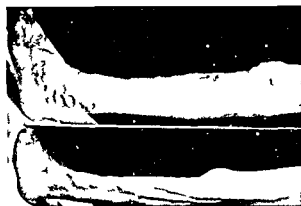


FIG. 1. (b) Distal part of the limb showing the site of the fistula. (c) Proximal part of the limb showing the site of the fistula. (Ca) (6)

blood may be reversed so that these vessel which function as arteries during one stage of development function as veins during another she mentions the subintestinal artery and the vena capitis medialis as examples. Woodlard's diagrams show clearly the capillary network through which the forelimb bud of the pig embryo first gets its blood supply and how at a later period when the subclavian artery and vein are beginning to be differentiated there are multitudinous communications between the two vessels. Because of this state of affairs existing in the embryo Reid (17) aptly expresses wonder that congenital communications between arteries and veins do not occur more frequently.

This embryological explanation also satisfactorily accounts for the multiple communications usually found in congenital case in contrast to the single communications usually present when the etiological factor is trauma. It is interesting that Reid in his congenital case of arteriovenous fistula between the subclavian vessels found that the artery and vein were each connected with the intermediate mass of dilated veins by a single vessel.

#### SITE OF OCCURRENCE

Whereas an acquired arteriovenous fistula may be situated anywhere in the body depending on the part traumatized congenital cases are somewhat more limited in their distribution the vessels of the trunk apparently being only rarely if ever affected although

Hewett diagnosed the lesion in his case as intra abdominal. This is the only example of the congenital type affecting the vessels of the trunk which has come to our notice. An analysis of our cases shows the sites of occurrence to be head 3 (scalp intracranial) 1) neck 2 and extremities 4. Of Reid's 5 cases 4 were in the head and neck (2 intracranial) and only 1 was in the extremities. It would seem therefore that the commonest sites of occurrence of congenital arteriovenous fistulae are the head both extracranial and intracranial and neck while the extremities come next in order of frequency.

#### THE EFFECTS OF ABNORMAL ARTERIOVENOUS COMMUNICATIONS

The usual effects of arteriovenous fistula in general may be considered from three aspects (1) local (2) regional and (3) general or systemic.

The local effects are those manifested by the affected blood vessels. The blood from the artery flows into the distal part of the vein greatly increasing the volume of blood in it and producing a pressure greater than the vein is normally capable of withstanding. As a result the vein becomes dilated and tortuous. Similar changes take place though probably not to such a great extent in the proximal part of the vein. The larger the fistula and the longer its duration the more widespread will be the venous involvement. In many cases almost all the veins of a limb which is the site of a fistula being affected. Reid (13) found in experiments on dogs that there was an increase in the elastic tissue in the walls of an involved vein (the so called arterialization). We were able to examine microscopically the veins in the vicinity of the anastomosis in one case only. We found no evidence of arterialization but calcareous degeneration was well marked in the internal part of the middle coat in one section (Fig. 11).

The effect of an arteriovenous fistula on the involved artery consists of dilatation thinning of its walls and degenerative change in its coats all these changes taking place in greater or less degree only proximal to the fistula. Holman (7) has drawn attention to

the fact that when the cross section of the fistula is small these changes may be hardly noticeable or even entirely absent although the fistula may have existed for many years whereas when the fistula is large they are invariably present particularly the dilatation and thinning in marked degree. As to the cause of these changes in the proximal artery opinions are somewhat divided. Some authors believe that the diminished blood pressure causes loss of tone and functional inertia which results in the changes just described. The objection to this theory is that the diminished blood pressure is general and since other arteries are not affected it would seem that the cause is local rather than general. Others take the view that the increased amount of blood flowing through the artery is sufficient to account for them. Reid (18) thinks that it would be unusual if a simple handling of an increased volume of blood by the proximal vessels did not lead to an hypertrophy and strengthening of their walls. While it is true that dilatation thinning and degeneration of the walls of the hollow viscera are often the sequelae of previous hypertrophy yet this is not always so and we offer another explanation of these changes. In the first place the dilatation is acute in support of this are the observations that it is present only when the fistula is large and that it occurs almost at once after the production of the lesion. Second the dilatation causes constriction of the vasa vasorum and this results in diminished nutrition of the vessel wall leading finally to thinning and degeneration.

The regional effects are those evident in the particular limb affected. The first is hypertrophy as seen in the increased girth and length of the limb. The latter indicates an overgrowth of the bones and is found only when the lesion has been established for some time before the ossification of the epiphyseal cartilages so that congenital cases are particularly liable to show it. The second effect is increase in superficial temperature and the third trophic changes. The first two can be explained by the increased volume of blood flowing through the limb consequent upon the production of the fistula. The trophic changes are produced by two factors first



FIG. 10. Left foot shows scab of amputation of toes and scab covering the d. cha. g. sinu. (Case 8)

the diminution of the flow of blood through the capillaries on account of its easier path of escape into the veins through the fistula and second the increased pressure on the veins impeding the return of deoxygenated blood from the capillaries. These two factors working together tend to bring about a state of anoxemia of the tissues affecting more particularly those most distally situated. On this account if these tissues become even slightly injured the normal inflammatory reaction necessary for their repair is either feeble or absent and hence chronic progressive ulceration (partial destruction) and later gangrene (total destruction) supervene. In Cases 5, 6 and 8 that is all those in which an extremity was affected chronic ulceration and gangrene were quite prominent features.

The general or systemic effects depend on the upset in the function of the circulatory system produced by the development of the fistula and also on nature's efforts at compensation. Normally the circulatory system consists of heart, arteries, capillary bed and veins. The formation of an arteriovenous fistula creates a new path through which the

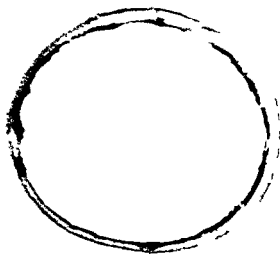


Fig. 1. A congenital  
arteriovenous fistula (Case 5)

flow a second system is  
artery fistula and vein be-  
-ed. The central point of the  
between the two systems is the  
fistulous system. The flow of  
peripheral resistance is always  
low along the path of the  
the peripheral resistance of the fistulous  
system the greater will be the tendency for  
blood to pass through it. In order that blood  
may still continue to flow through the capil-  
lary system with its high peripheral resistance  
it is essential that an adequate general blood  
pressure should be maintained (Holman 7).

The systemic effects may be considered  
from three aspects (1) peripheral resistance  
and blood pressure (2) total volume of cir-  
culating blood and (3) the reaction of the

in 3 (Cases 2 and 4). On closure of the fis-  
tula (and the re-establishment of the  
normal peripheral resistance) the diastolic  
pressure rose to normal while the systolic  
pressure only remains about the same al-  
though there may be a transient rise. Hoover  
and Leach reported that on closure of the  
fistula the systolic pressure rose by the same  
amount as the diastolic but in most of the  
repaired traumatic cases the systolic as  
already mentioned remains the same or rises  
only a few points. As multiple anastomoses  
are present in congenital cases these changes  
in blood pressure are difficult or impossible to  
achieve because of the difficulty of closing all the  
fistulae simultaneously.

Holman has pointed out that because of  
the easier path of escape offered to the blood  
from the arterial system by an arteriovenous  
fistula the amount of blood passing through  
the system heart arteries capillaries and  
veins is reduced according to the size of the  
fistula that in order that the supply of blood  
through this system will be sufficient for the  
need of the body an adequate general blood  
pressure must be maintained and that one  
of the compensatory mechanisms to insure  
this is an increase in the total volume of the  
circulating blood. He proved his theory to  
his complete satisfaction by experiments on  
dogs in which he had produced arteriovenous  
fistulae showing that when the lesion was  
small (and therefore the amount of blood  
short circuited back to the heart was cor-  
respondingly small) the blood volume re-  
mained constant or nearly so while with  
larger fistulae he found a definitely increased

centimeters for each kilogram of body weight may be regarded as normal for different healthy individuals. On the other hand the blood volume in the same healthy individual estimated at different times under comparable resting conditions may vary as much as 5 cubic centimeters for each kilogram. The single case in our series (Case 8) in which the blood volume was determined before and after operation showed a fall from 106 to 88 cubic centimeters for each kilogram of body weight after ligation of the main arteries involved a decrease greater than the normal variation. This single piece of clinical evidence though supporting Holman's experimental results does not justify any definite conclusions being drawn. However we hope in due course to have the opportunity of studying blood volume in a sufficient number of cases to be able to satisfy ourselves as to whether the data in this single case can be satisfactorily corroborated or not.

In many of the cases reported in the recent literature on the subject enlargement of the heart has been noted sometimes accompanied by symptoms or signs of myocardial degeneration. Until comparatively recently it was thought that the heart condition was coincidental and that if the state of the heart was poor the surgical risk was correspondingly great and operation contra indicated. During the war however observers had the opportunity of studying a large number of cases and they began to recognize that the condition of the heart was not coincident with but consequent on the production of the fistula. One of the most striking cases is reported by Leriche. This surgeon extirpated an arteriovenous aneurism in a patient in whom considerable cardiac enlargement and general signs of cardiac decompensation were present. The heart returned to its normal size and the signs of decompensation disappeared. This case together with later abundant experimental work and clinical investigation by the Americans Holman (7, 8, 9), Matas, Reid (15, 16, 17, 18, 19), Hoover and Beams and the Englishmen Lewis and Drury has completely proved the detrimental effect of abnormal arteriovenous communications on the heart. Opinions differ as to the cause of the

cardiac enlargement. Lewis and Drury maintain that it is largely due to dilatation consequent upon faulty nutrition of the myocardium the low diastolic pressure being insufficient to permit of adequate filling of the coronary vessels. On the other hand Holman (8) in experiments on dogs found that in addition to dilatation there was an increase in the weight of the heart which he concluded must be due to hypertrophy. In our series cardiac enlargement was only demonstrable in 2 cases (Cases 3 and 5). It did not occur in any of Reid's cases.

An arteriovenous fistula has been described as analogous to an aortic leak but whereas in aortic regurgitation the left side of the heart alone undergoes dilatation and hypertrophy as a compensatory measure in arteriovenous fistula both sides of the heart undergo these changes the right side on account of having to cope with the increased intake consequent on the abnormal escape of blood into the veins through the fistula the left in order to increase output to maintain adequate general blood pressure. If Holman's contention be correct in addition to these factors the heart has to deal also with increased total volume of blood.

Branham in 1890 noted that in these cases closure of the fistula produced slowing of the pulse rate this observation has since been spoken of as Branham's bradycardiac phenomenon. It could not be elicited in any of the congenital cases in this series because of the difficulty in closing the multiple communications. When an arteriovenous fistula is closed the blood has to flow through the circulation heart arteries capillary bed and veins so that the peripheral resistance of the arterioles is again brought into play with resulting increased peripheral resistance and consequent raising of the blood pressure. The slowing of the rate of the heart is therefore in accordance with Marey's law that the pulse rate varies inversely with the blood pressure. The mechanism by which the pulse rate is adjusted in this manner has long been regarded as reflex it being thought that a rise in blood pressure by stretching the wall of the aorta stimulates the endings of the depressor nerve as a result of this the cardio-inhibitory center was thought to be excited and that the impulses

TABLE V—CLINICAL MANIFESTATIONS AND TREATMENT OF CONGENITAL ARTERIOVENOUS ANEURISM

C	S	Les	E d d f h g	P	Blood		T ph hang	D	Typ f p t	D	Res l	R ma k
					Sy l l	Dias l						
F		C so d gh d eck	S m t l m pe	84	6	8	N	8 3 6	Lg al f ight d	—		R p d f m ed l t b h es f m
f		A b m b d w	N		5	7	N	8	L t l f d	—	W ll	
M		A m b l eu m bcl f l	H l g d		5		Righ m d hyp l p h d w k d g g m	6 0-0 0-0	L f gh l y L d l f gh y	+	N be fit N be fit	C g l f g h t l f g l a Rght m mp ed t b d f bru ry s ( l b )
M		C so d l m f	N				N	3	Dis ec f o m	—	C ed	
5	M	A m so d ype g l ea m		8	R b 3 Le f 60		Hype ph m g h	6	Ea f t mnt b l t ry and	+		A phy i g ne f h d l phala es la oces d mp t f f p l a m k tly d m hed
			H l t m k l g d	85	8		T ph l f g h d	6-5	Amp t f m m d l l f f	+	W ll	
6	I	A m f igh foo	Lef l hype m phy d m l l	8	3	7	U l d m f igh foot	5 4 7 0-	L f b l d m Amp t t f p p d m d d l th d f ht l	—	W ll	
7	f	S b m l m d	N		5	78	N	30-3 -6-3 3 3 5	Lug l f l f l d Lug f h d D se t f ism Dis ec f m	— — W ll		Th y d m l m d m l gh p l a sa m l g b-
8	6 L	A m d yd l f foo	N	8	8		T h l rs f es	6-6-5 8-5	Lug ped f d val b l d po es Ampu t f l f l g		W ll	
9	6 M	In l io h l eu m ph t mos f l f y	N	98	8	5	N	7	L m f l f m d		Si h ly m d	T m k d l d d b lru mos ul p b h l t

Case b l ed b f tal gun ggr ed by d t g f

from this center by way of the vagi brought about a reduction of the pulse rate. In this connection we would like to draw attention to the recent work of Anrep and Starling which seems to necessitate some modification of this view of the reflex causation of the phenomenon on which Marey's law is based. In the experiments they used a method in which by means of a heart lung preparation the circulation through the brain of an animal is entirely under the control of the experimenter while the animal's own heart supplies only the trunk and limbs. By such an arrangement the circulation through the vasomotor and cardio-inhibitory centers is entirely unaffected by changes in the action of the heart or in the circulation through the trunk and limbs. The nervous connections between the brain and the heart of the same animal were undisturbed. It was found that when the pressure in the brain was raised the heart was slowed if both vagi were intact but not if they were divided but rise of blood pressure in the animal's own aorta caused no such reflex alteration in the rate of the heart beat whether the vagi were intact or not. The slowing expressed as Marey's law therefore would seem to be explicable not by reflex through the fibers of the depressor as has been commonly supposed but by the direct effect of the raised arterial pressure on the cardio-inhibitory center.

In cases of arteriovenous fistula the diastolic pressure is lowered while the systolic is practically unchanged thus the mean arterial pressure is lowered. This no doubt accounts for the increased pulse rate observed both clinically and experimentally in these cases in accordance with Marey's law. A pulse rate above 80 was noted in 5 of our cases (Cases 1, 3, 5, 6 and 9).

#### TREATMENT

Surgery provides the only effective treatment of congenital arteriovenous aneurism. In order to treat successfully any arteriovenous aneurism the abnormal communication or communications between the arterial and venous circulation must be permanently broken. To accomplish this the fistulous tract must be destroyed by excision or division or its lumen obliterated as by ligation or clotting or the

fistula or fistulae including segments of the adjacent arteries and veins must be isolated from the circulation as by multiple ligation of the artery and vein.

There are reports of numerous cases of traumatic arteriovenous aneurism both experimental and clinical in which spontaneous clotting and subsequent healing have occurred under non-operative management. Nearly all of these aneurisms have a small fistulous tract and are of recent development usually within 2 or 3 months but there is no justification for non-surgical measures in any case of arteriovenous aneurism which has lasted 6 months or longer in the reasonable expectation of causing the fistula to heal. In the congenital arteriovenous communications success from non-surgical measures such as injections of anticoagulants, cautery, puncture and irradiation is limited to the occasional small nevus or pulsating hemangioma. In all others cure is effected only by radical surgical measures.

In the main the symptoms of congenital arteriovenous aneurism are similar to those of the traumatic type yet the treatment of the former presents inherent problems that are not often encountered in the acquired aneurism. The additional difficulties in treatment arise from the differences in the pathological anatomy. In the traumatic type the communication established in most cases by a penetrating wound is usually single and often involves the larger vessels accessible to surgical approach. Here the problem is restricted to checking the arterial leak without interfering with the blood supply of the tissues beyond. With the diversion of part of the arterial blood through the leak the blood supply of the tissues distal to the fistula becomes impaired. Collateral circulation is thereby stimulated and invariably becomes well established so that the choice of any of the several accepted operative procedures may be selected usually without fear of gangrene of the extremity.

The operative procedures which are of proved worth in the treatment of arteriovenous aneurisms include (1) excision of a segment of the affected artery and vein including the fistulous tract (2) isolation and ligation of the fistulous tract with silk (3) restorative angioplasty which may be accomplished by one of



three methods division of the fistula and lateral suture of the opening in the artery and vein the Matas Bickham transvenous method of closure of the fistula and endo aneurismorrhaphy (Matas) in certain cases of varicose aneurism and (4) quadruple ligation of the artery and vein proximal and distal to the aneurism

The operation of ligation of the proximal artery alone is mentioned only to condemn it as an obviously unsound procedure suitable for only one type of arteriovenous aneurism the intracranial lesion of carotid cavernous sinus fistula or pulsating exophthalmos When the proximal artery alone is ligated in the case of an arteriovenous aneurism involving important vessels of an extremity the blood supplied to the parts distal to the anastomosis by way of the arterial collaterals will flow in the direction of least resistance that is in a retrograde manner through the distal artery by way of the fistulous opening back to the heart The greater part of the collateral circulation will then be shunted back to the heart without furnishing adequate nutrition to the extremity thus trophic sores or gangrene become inevitable

In cases of intracranial arteriovenous fistula direct attack on the fistula is impossible Experience has proved that a great many of these involving the internal carotid and the cavernous sinus particularly those of traumatic origin are ameliorated and frequently cured by proximal ligation of the internal carotid In such instances the communicating tract must be small to favor closure by clotting But even so it is difficult to understand how cure is effected unless it is that the slowing of the blood stream through the fistula incident to the ligation of the carotid is more marked than usual This might be explained by the additional obstruction to the flow offered by the trabeculations in the cavernous sinus permitting clotting in the fistulous tract to occur before the secondary rise in blood pressure in the distal carotid after the reestablishment of the collateral circulation

The one recorded case of a congenital arteriovenous aneurism with a single communication is that of Reid already referred to In this instance the difficulties encountered made it

necessary to perform the operation in two stages and to apply 10 ligatures to important arteries and veins to bring about cure However in most cases of congenital arteriovenous aneurism there are multiple communications between the arteries and veins often between the small branches This fact materially complicates the treatment for to effect a cure not one but all of the communications must be destroyed The treatment therefore must be directed at the extirpation of the mass of dilated vessels and their communications as in superficial cirroid aneurisms or the affected limb must be amputated In 3 cases in this series in which a limb was involved a maximal thrill could be felt over one of the larger arteries which suggested that the communication was single and an operation was advised with the view of extirpating the fistula After exposure of the vessels a definite anastomosis between the artery and its two venae comites was found and extirpated after both artery and veins had been sacrificed Following this procedure however in each case the circulation in the distal part was definitely diminished gangrene resulted and amputation of the limb became necessary Subsequent radiological examination and dissection of two of these amputated limbs showed scattered diffusely through the limb numerous communications between the arteries and veins many of only minute dimensions the presence of which precluded the possibility of any effectual surgical treatment of the anomaly other than by amputation

The time to institute radical operation should of necessity vary with each patient the site and the rapidity of the growth of the lesion the degree of local disability and the presence or absence of systemic changes should be taken into consideration in making the decision It is conservative surgery to extirpate the superficial arteriovenous aneurism in early life before extensive growth takes place otherwise more radical measures resulting in more marked disfigurement will be necessary In the absence of cardiac change amputation of the limb for congenital arteriovenous aneurism involving the deeper vessels of an extremity can be safely deferred until inconvenience and disability demand it

## CONCLUSIONS

1 A consideration of the congenital cases reported establishes the following points of difference between them and those of the acquired type (a) there were multiple communications between arteries and veins as opposed to the single communication usually obtaining in traumatic cases (b) while the local and regional effects were similar to those found in the acquired type the general effects were not nearly so well marked and (c) the effects of the congenital form were produced much more slowly. It would seem that these last two observations may be attributed to better adaptation of the cardiovascular mechanism when the abnormal condition exists from birth.

2 The head and neck are the most common sites of occurrence the extremities coming next in order of frequency. The vessels of the trunk are rarely if ever affected.

3 On account of the frequent presence of multiple communications and the progressive nature of cases of the congenital type they are more liable to necessitate radical amputation than are the acquired cases.

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## THE DISTAL ANTERIOR CLOSED SPACE INFECTION

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FOR many years Kanavel (3) and Auchincloss (1) have stimulated assistants and students to a better understanding of hand infections. There are many fundamental surgical principles which can be brought out while teaching the distal anterior closed space infection. Although designated as a minor surgical condition it frequently terminates as a major problem both for surgeon and patient. The discomfort, loss of time and occasional deformity which result make it evident that early recognition and proper treatment of this infection are necessary. I believe as a synonym has been discarded in this paper because as this term is generally used it may signify an involvement of too many other adjacent anatomical spaces or structures.

Industrial surgery has made possible the accumulation of many hand and finger cases for statistical purposes. In one insurance company (5) 63 per cent of all the hand cases were found to be due to infections following small injuries and the remaining 35 per cent included fractures, lacerations and crushing injuries. The combined statistics of 5 other insurance companies show that 15 per cent of their cases were treated for injury of the hand and that one fifth of these had infection. The latter caused 73 per cent of serious deformities of the hand (2).

In order to get certain specific data on the condition under discussion 45 consecutive ambulatory cases were studied at the Presbyterian Hospital according to a distinct scheme as seen in the accompanying table. It must be understood that accurate conclusions cannot be drawn from these statistics alone. There are so many variable factors that definite impressions acquired from experience with hundreds of other cases should not be excluded.

## THE ANATOMY

A careful study of the anatomy (Figs. 1 and 2) is essential to an understanding of the

pathology of this infection. The distal anterior closed space is a confined small compartment on the volar surface of the finger. It extends from the distal crease to the tip. Posteriorly it is bounded by the volar aspect of the phalanx and laterally by fibrous tissue septa which separate it from the paronychium. It contains the following structures: fat pad, fibrous tissue septa, blood vessels, nerves, sweat glands, lymphatics, periosteum and the insertion of the tendon of the flexor profundus digitorum at the proximal end of the distal phalanx. The flexor tendon sheath begins at the base of the distal phalanx and is included in the distal anterior closed space. It does not completely surround the tendinous insertion. The glands are superficial and quite numerous. Klapp and Beck (4) have demonstrated them even near the periosteum.

The fibrous tissue septa, strong penetrating connective tissue fibers, run radially and centripetally from the thick skin and corium to the periosteum. This latter is composed of two layers: an outer which is loose connective tissue fibers and an inner with a considerable amount of elastic tissue running in parallel bundles close to the bone.

The blood vessels of the inner layer are smaller than those of the outer layer and are intimately connected with the bone marrow by perforating arteries. The blood vessel enters the cortical bone through the Haversian and Volkmann canals and anastomoses with the vascular system of the bone marrow. The fibers of Sharpey (periosteal prolongations into the bone) end in the interstitial lamellae. The terminal portions of the digital arteries, lying anterolateral to the distal phalanx, are the primary trunks for the blood supply of the space and bone. The epiphysis receives its blood supply from a small independent volar digital branch which is given off on either side of the base of the phalanx before the main digital branch enters the closed space. The venous return from the bone marrow is chiefly through the vein emerging

from the nutrient foramen usually situated on central part of volar aspect of the phalanx.

The superficial lymphatics form a diffuse network and drain proximally into the axilla. Roux (6) believes that there are lymphatics which run perpendicularly from the skin to the periosteum. These have not been definitely demonstrated. The phalanx is composed of a terminal tuft which is cortical bone, a diaphysis with its medullary cavity, and a proximal epiphyseal portion which is also cortical bone.

#### ETIOLOGY

It must be remembered that these cases were studied in a general hospital. They were most frequent in the second and third decades and were divided about equally between the sexes. Manual laborers and housewives were in preponderance. In the vast majority of cases the patient remembered a prick in his finger from a sharp object such as a pin, a bone or a splinter. In other instances there was a history of a superficial abrasion, a cut, a slight burn or a continued contusion. Many times a trauma is not recalled.

#### PATHOLOGY

With the introduction of bacteria either directly or through the lymphatics, the infection may be originally superficial and then spread to the deeper parts, or it may take its inception in the deeper parts first. In the former case a small pustule is formed, the contents of which travel along the path of least resistance perpendicularly or obliquely downward between the fibrous tissue septa and into the fat pads. After they reach the comparatively avascular fatty tissue, fat necrosis takes place. In the early stage of the infection there is no free pus. Most frequently the superficial pustule and the deeper necrotic area are larger in diameter than the sinus that connects them, hence the familiar name "collar button infection" (Fig. 3). The infection may start at the tip of the finger and burrow directly backward hugging the tip or volar aspect of the phalanx, or it may start directly in the center of the closed space laterally or proximally. The statistics compiled from our 45 cases show that the majority of the infections occur distally.

The infecting organisms in their order are the staphylococcus aureus and albus, the streptococcus, the colon bacillus, and as a contaminant the pyocyanus. Human bites cause a mixed infection which also yields anaerobes. Cases infected with pneumococcus, gonococcus, and diphtheria bacillus have been reported. (4) The reaction from these organisms is generally the same in this infection as in most parts of the body. Thus the staphylococcus is prone to produce much pus and slough, while the streptococcus gives a great deal of pain with lymphangitis.

The phalanx may become involved in one of three ways: first by infection carried through the lymphatics which run perpendicularly to the bone and underneath the periosteum; second by thrombosis of the blood vessels supplying it subsequent to the marked increase in pressure in the confined space; (3) by direct spread of the infection to the medulla through the nutrient foramen. The treatment of this complication to be discussed later is based on the fact that no involucrem such as is formed almost everywhere else in the body develops in this bone. Klapp and Beck (4) have expressed a thought in this connection that seems correct. Ordinarily osteomyelitis begins in the medulla and the pathological process spreads to the cortex and periosteum through the Haversian systems. In this way the periosteum is stimulated and subsequently an involucrem forms. In the distal phalanx, on the contrary, the periosteum is the first to suffer severely. Regeneration therefore cannot take place until the sequestrum has been removed to allow subsequent periosteal and endosteal growth.

#### SYMPTOMS AND SIGNS

After the introduction of bacteria into the tissues, the patient usually begins to have pain within the first 24 hours. It becomes throbbing in character and usually causes a sleepless night. Elevation of the finger and hot soaks may give relief. With the breaking down of tissue the pain usually becomes less. The constitutional symptoms as a rule are not very marked, chills and high temperature seldom occur. In the earlier stage the end of the finger is tense and subsequently there

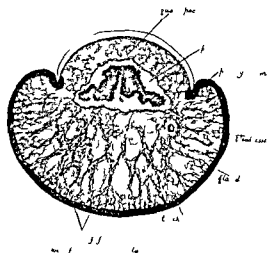


Fig 1 Vertical cross section through the distal phalanx (Adapted from Kana)

may be a brawny induration but rarely fluctuation. Swelling, redness, heat and exquisite local tenderness are marked. The digital vessels can be felt to pulsate with greater force. If the infection has collar buttoned the top of the blister may be seen intact or in those cases in which there has been extensive liquefaction open and exuding pus. There may be a great deal of swelling of the paronychium and eponychium. This frequently causes an incorrect diagnosis and results in many unnecessary incisions. There is usually slight interference in motion of the distal phalangeal region. Lymphangitis is not common and when present may indicate a severe infection. All these symptoms and signs vary with the pathological involvement. Erysipeloid with its redness and occasional tenderness must not be mistaken for this infection.

#### COMPLICATIONS

Those complications will be considered which occur in neglected cases which have not been treated surgically. The most frequent is osteomyelitis in which the method of bone involvement has already been discussed. The tendon may become involved but rupture of the infection into the tendon sheath is very unusual. There seems to be a distinct walling off process of the sheath and its comparatively good blood supply may be a factor in its preservation. Later the interphalangeal joint

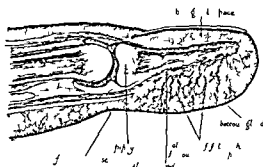


Fig 2 Horizontal section through the distal phalanx (Adapted from Kana)

may be affected and subsequent to this a localized tenosynovitis or an involvement of the dorsal subtendinous or dorsal subaponeurotic space may result. Rupture of the infection into the eponychium and paronychium or subungual space occurs infrequently. There may be a direct extension underneath the crease to the middle interior closed space. From this point a lymphangitis with its subsequent sequelae are frequently seen. Thrombophlebitis, sepsis or metastatic pus foci occasionally occur. A detailed account of the paths of extension of infection has been given by Auchincloss (1).

#### PROGNOSIS

The prognosis in cases treated early and properly is good and the average duration of treatment until complete closure of the wound is about 3 weeks. In case reporting late for treatment or in those improperly treated or in those having constitutional conditions such as arteriosclerosis, diabetes and syringomyelia the various possible complications make the prognosis for the time of disability and end result inaccurate.

#### TREATMENT

Conservative treatment rarely produces a good result and should ordinarily be discouraged because it is likely to prolong disability and unnecessary suffering. The removal of the top of the blister in a low grade infection in case there is involvement of only a very small amount of fat occasionally produces a cure. In the average case when the diagnosis has been established surgery is immediately indicated. It is unfortunate that

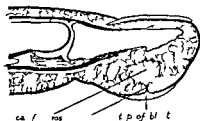


Fig 3 Scheme of a typical collar button abscess

TABLE I ANALYSIS OF FORTY FIVE DISTAL ANTERIOR CLOSED SPACE INFECTIONS

Age	N	mb	P	C	t
Under 1	1				2
11 to 20	10			22	3
1 to 30	15			33	3
31 to 40	8			17	8
41 to 50	7			15	5
50 to 60	4			8	8
Sex					
Male	22			48	8
Female	3			51	2
Occupation					
Manual labor	3			51	06
Domestic	16			35	50
School	5			11	00
Infant	1			2	20
Type of wound					
Needle puncture	11			4	40
Unknown	10			2	20
Splinter puncture	9			20	00
Incised wound	6			13	30
Burn	3			6	60
Abasion	3			6	60
Contusion	2			4	40
Secondary infection	1			2	20
Location of focus					
Distal	13			28	86
Lateral	1			26	64
Central	11			24	42
Unknown	5			11	00
Proximal	4			8	88
How it appeared first					
Pain	35			77	80
Swelling	8			17	80
Blister				4	40
Incubation in case of pain					
Unknown	14			31	08
First 24 hours (immediate)	1			26	60
1 to 3 days	10			2	20
3 to 7 days	5			11	10
1 to 2 weeks	3			6	60
More than 2 weeks (7 weeks)	1			2	20
Time after pain subsided that relief was sought					
3 to 7 days (most on fifth day)	5			57	70
1 to 3 days	17			37	74
10 days	1			2	0
Unknown	1			2	0
X-ray findings					
Not indicated	38			84	36
Extensive osteomyelitis	3			6	66
Beginning osteomyelitis	2			4	44
No X-ray	2			4	44



Fig 4 A half elliptical incision divided into its components—lateral bilateral and hockey stick

Anesthesia					
General	32			71	04
Local	13			29	96
Type of incisions					
Bilateral	18			39	96
Lateral	9			17	60
Horseshoe	6			3	32
Hockey stick	5			11	10
Hockey stick long	3			6	66
Hockey stick transverse	4			4	44
Spontaneous rupture	1			2	22
Culture					
Staphylococcus aureus hemolyticus	32			17	04
Staphylococcus aureus	6			13	35
Unknown	4			8	86
Staphylococcus albus	1			2	22
Streptococcus hemolyticus	1			2	2
Gross pathological findings					
No pus	2			4	40
Few drops to 1 cc	4			4	18
1 cc to 5 cc and slough	9			19	98
12 cc	1			2	20
Collar button abscess	3			6	66
Necrosis of bone	3			6	66
Involvement of mid space	4			4	44
Subungual abscess	1			2	20
Length of drainage					
48 hours	30			66	60
No drain	4			8	80
41 hours	4			8	80
72 hours	2			4	40
3 to 7 days	5			11	1
Postoperative complication					
Most cases had none					
Itis					
Postoperative sequelae					
Most cases had none					
The minority had epithelial clefts					
Time of disability					
Average disability 23 days lowest 6 days longest 5 months					
End results					
Most that could be followed were good					
The others had epithelial clefts clubbing and stubbing of finger disturbances in sensation loss of substance or distortion of terminal phalanx					

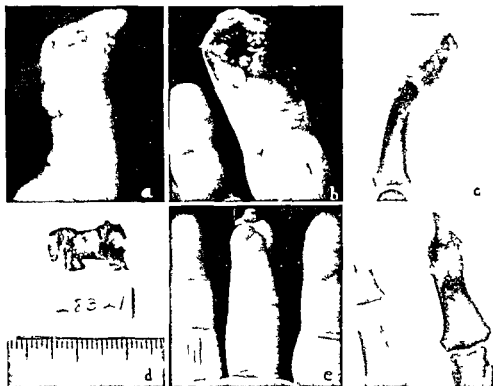


Fig 5 C N 005 Ad t l t l d p f t n f th th mb b C  
 N 09057 App f d t l t l d p i fect th m pl t teomyl t  
 6 d y ft op t o P tg am f m f k G h sl N t l m nt f  
 bo d t p phv d App f ph l f m l ft m l U s l  
 d lt ft 6 m th h puth l l l ft l f b t t bb g d l bl  
 f th h d c t f th l f R tg g m f t m l ph l f h h  
 I gu N t th t t d d c l ph l f od d b th t m tr ct f  
 th ly g ft p t

relief for the condition is usually sought rather late. From our own statistics about 57 per cent of the cases reported for relief from 3 to 7 days after pain began and most of the others between 1 and 3 days after. A frequent error is an attempt to draw out the pus with poultices, hot soaks or the black salve (ichthiol) which the corner druggist has given the patient. Removing the top of the blister or pricking it with a needle and squeezing out pus is another common practice. Clearly with such treatment the necrotic fat pads do not receive proper drainage and no relief is obtained at all; it is only temporary. An incision which is made without the use of an anesthetic is usually inadequate and causes unnecessary torture to the patient and a break in morale which is subsequently difficult to overcome.

#### THE PREPARATION OF THE PATIENT

The skin of the affected area is cleaned carefully and gently first with soap and water and then with lime and soda. Then follows immersion of the hand in an antiseptic solution such as potassium mercuric iodide 1:3000. Tincture of iodine applied directly is likely to obscure the field, burn the skin and cause unnecessary death of epithelium. Strict asepsis must be enforced. A general anesthetic such as gas and oxygen or ethyl chloride is to be preferred. If this is contraindicated block anesthesia—catching the digital nerves at the base of the finger—should be used. The finger is elevated for about a minute and a rubber band tourniquet applied at its base. A clamp should always be attached to the tourniquet to insure its removal. The bloodless field produced by the tourniquet is

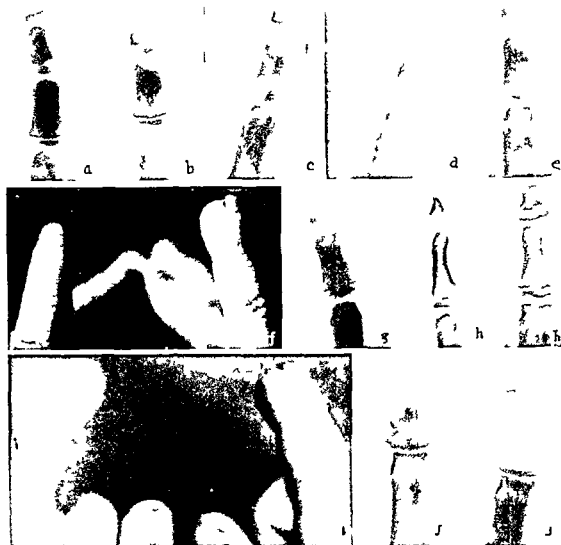


Fig 6 a Sequestrum at epiphysis in 7 year old boy. b Appearance of same finger as in Figure 6a 7 days after sequestrectomy. c 28 days after sequestrectomy. Note the increase in bone production. d Fifty one days after sequestrectomy. e Seventy nine days after sequestrectomy. f External appearance of finger in Figure 6c at this time. Note clubbing and incurvation of the nail. g Appearance of finger shown in Figure 6a 93 days after sequestrectomy. h Four and one half years after sequestrectomy. Note the unusual intact epiphysis. i External appearance of finger in Figure 6h. There is little change from condition shown in Figure 6f. j A sequestrum which was absorbed and the result after 6 months. Note the distortion of the phalanx and the absence of a rounded terminal tuft.

sentral to determine the amount of pathological involvement which is a guide for the length and depth of the incision. Ethyl chloride as a local anaesthetic is very unsatisfactory in this condition.

#### THE INCISION

The incision should cut across fat pads and fibrous tissue septa transversely so as to drain the entire area. It should be so placed as to avoid injury of a larger blood vessel, nerves or tendon sheath. A vertical incision into the infected area is hardly justifiable except per-

haps in the proximal portion of the closed space where according to Auchincloss (1) the ideal incision is more likely to injure the tendon sheath. Reference to the accompanying photograph (Fig. 4) will show a half ellipse or horseshoe which can be divided into lateral, bilateral and hockey stick incisions. In all of them the entire necrotic or purulent area should be exposed. The type of incision will depend upon the extent and the site of the infection. Any incision compatible with the extent of pathology which will preclude the



TABLE II—FORTY FIVE CONSECUTIVE DISSECT

Age	N	Sex	Time of day	Time of day	Time of day	Time of day	Time of day	Time of day	Time of day
53	—	I	m k	I	—p	L	l	h	h
500	—	S	h o l	I	e e—	T	i	P	h
—	—	H	l	I	— dl			S	h
—	—	H	ew k	P	—	I	l	P	h
—	—	D	k	I	l e—	L	l	I	h
—	—	M	d		h k f	T	f h	I	h
—	—	h	l	Bl	—t	T		P	h
—	—	h	l	I	j l	L	l	P	h
—	—	ack		I	k f j—	L	l	I	h
—	—	N		I	j— l	L	l	I	h
—	—	I	k	B		I	l	I	h
—	—	M	d	P	j d—	I	l	I	h
—	—	I	k		h k f	I	l	I	h
—	—	P		U	k	I	l	I	h
—	—	D		P	l e—	I	m l	I	h
—	—	U		C	—o h ll	I	l	I	h
—	—	l	k	P	dl e—	I	l	I	h
—	—	Op		C	—l	L	l	I	h
—	—	T	mm	P		L	l	I	h
—	—	hool		P	e—	C	l	P	h
—	—	C	k	I	l e—	D	l	P	h
—	—	L	b	P	pl e—	P	um l	I	h
—	—	b	m	C	l	P	m l	P	h

## ANTERIOR CLOSED SPACE INFECTIONS

Aesthes	Type f	C h	P th l g l f l g	T y p f d g h g	T m d b i t y D y	E f l t
N oca	L t l	St phyl	I d p f p	I bb d m—48 h		
N	H k y t k	St phyl	s dr p f p Sl gl	R bb Chl m ky—48	5	
N tr and d gas y g	P t l m h	St phyl —ham lyt	I ee p d l gh	Chl m ky bbo—48	5	
N tro d gas y g	B l t l	St phyl	m p	R bl l m th gh l th h— d y	4	
Ethyl hl de— l	L t l	St phyl	? P f ll w g d y	R tbo—48 h (R pl d l t )	48	
N	H h	St phyl oc —ham lyt cu	Th k g y g p — l gh	R bbo Chl m ky—7	4	
N tro d g y g	H esh	St phyl oc —ham lyt	M h th k g p l l p f d p o d d p tly d g t l by f t	Chl m ky bb —7	8	
N	Lat l	B p t m t	C pl f dr p f g y	S l k p k g Chl m ky —48 h	3	
N	H h	St phyl oc lb	C d bl b h p l t m t l d t b N t gh d	Th gh d th gh g p k g—7	7	
Ethyl hl de— l	H k y t k	St phyl oc	d p f p — p ec f pl t	N		
N tro d g y g	B l t l	t phyl —ham lyt	s m p		35	
N oca	L t l	St phyl —ham lyt	P	G od f m	4	S f l t
N tr d gas y g	L t l	t phyl oc —ham lyt	Sm ll m t f p	Chl m ky bb — day	6	
N tr and gas y g	L t l	St phyl cu —ham lyt	C ty—sm ll m t f p	Chl m ky bbo — d y	4	
Ethyl hl de— l	L t l	St phyl oc —ham lyt	F w dr p f p	R bb d m— d y	8	
N tr us d gas y g	P l t l	St phyl oc —ham lyt	Sl gh—sm ll m t f p	d y	7	
N oc	L g f by t d doct	?	P	R bb — d y	3	
N tr us d gas y g	L t l	St phyl oc —ham lyt	C d bl p — g h l gh m m t g t d p p o k t	Chl m ky bb — d y	3	
N tr us d gas y g	B lat l	St phyl —ham lyt cu	M d t m t f p	Th gh d th gh bb d m— d y R pl d d y f t f d y		
N tr and gas y g	Hock y t k	St phyl —ham lyt	s m th k h t p	R bb dam— d y R kb — d y		m E d f l k t d w th I d t d f f n
N t and gas y g	B l t l	N g th	m th k p	R bb d m— d y	5	y S t P t d f f n g y g l d
N tro and gas y g	C t l	St phyl oc —ham lyt cu	P d l gh	R bbo—5 d y	4	m th L t f l l p t bl
N tr us d gas y g	B l t l	St phyl oc —ham lyt	P d ec t m t l m	Th gh d th gh bb d m— d y	3	



## ANTERIOR CLOSED SPACE INFECTIONS—Continued

A æ thes	Typ f	C lt	P th l l f d	Typ f d l t h g	T m d b l t y D y	E d l t
F thyl hlo de— g l	H hoe	t phylloc —hæm lyt	S m th k g h y ll w p f t I m t f b g u l p	C e—s d y	9	
E thyl hl de— g l	Hock y t k	St phyllococ lb	m th k y ll l gh d p S t d t t	R bbo —9 d y		
E thyl hl l— g l	Spo t	St ptococ — hæm lyt	D l k l g p pock t l gh d b t t ph l B gh l	G e—48 h	5	
S tro s ud gas and yg	B l t l F l wh d y p l	St phyllococu —h m lyt	P Nec m d l l J i p d t	R bb d —48 h	5	
N block	H h	t phyl —h m lyt	P m l t t t pec l t m d l	R bb d m—6 d y	9	
S tro s ud gas d yg	A t t l	St phyl	N p l t d	I bb —d y	6	gl g h m m l T f e th
S tro s ud gas and yg	L t l	St phylloc —hæm lyt	d p th k y ll w p	R bb l m—d y	5	
k tr d gas d yg	B l t l	St phylloc —h m lyt	d p th k y ll p	R bb d m	3	m S t C ld F th th fi g f l l d g th l t t
S tro d gas d yg	B lat l	St phyl —hæm lyt cu	4 m p —	R bb d m—d y	8	6 m N mb 6 m l h tly t d
k tro d g d yg	B l l	N g th	dr p p	R bb d m—4 d y		
S tro s ud gas d yg	B l t l	St phylloc —hæm l t	m p C d bl l gh	R bb t R bbo —3 d y		
S tr d gas d yg	B l t l	N t k	?	Th gh d th gh bbe d bbo	3	
E th l hl l— th	B l t l	St phyllococ —hæm lyt	d p th k y ll p	R lbe d m thr gh l thr gh—d y	3	
F th l hl de— l	B lat l	St phyl —hæm lyt	p m d k gr h p	Th gh d th gh bb	6	5 m S gh t ft t g m l f ung S min ld th d ld
L th	Hock y t k	t phylloc —hæm lyt	F wd p f p bm lig h l gh t k t ph l n	Chl msky lbb — d y	3	m S f lm t ft h lung 3 m ths
S tro d gas d yg	B l t l	St phyl oc —hæm lyt	C ll b tt bsc	Th gh d thr gh bb d m—d y	4	5 m N mb 3 w k ft r h t g p l l d mp th
E thyl hl de— g l	B l t l	St phyllococu —hæm lyt	p m th k y ll h	Th gh d th gh bb d m—d y	6	6 mos N mb ld l t m q kly th
E thyl hl de— g l	B lat l	St phyllococ —hæm lyt	p m th k y ll ish p	Th gh d thr gh ubb d m—d y	9	
F thyl hl de— g l	H esbo	St phyl oc —hæm lyt	m p — mod t ec os	R bl th gh l th gh—d y	9	m S is m ll N mb Hype th
F thyl hl de— g l th	B lat l	St phyl —hæm lyt cu	m p	R lbe th gh d th gh—d y	4	
S tro s ud gas and yg	I l l l	N g th	N p f d	N dr g		
F thyl hl de— g l	H h	t phyl —hæm lyt	m p l gh ec os q t m	Chl m kyp k—d y lod f m—d y Rbbo —3 d y	39	3 m Adh ent d l ft t Fp th l l C is rv t f f th ung q k th

N m p l t w t ed f p t pt Cas 5439 teomy l t C 09 75 p h t l cl ft d po y h d C  
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possibility of retraction of a flap or interference with sensation at the end of the finger is to be preferred. The half elliptical incision itself should be used sparingly but may be indicated for an infection which has already perforated the tip of the finger.

Free slough should be removed and if a loose sequestrum or foreign body is present it should be picked out. Klapp and Beck (4) recommend excision of the necrotic area or if this is not possible its curettage. It is preferable to wait for a line of demarcation. If this is not done, tissue might be removed which has a good chance of living. The less necrosis and removal of fat pads the less will be the chance of a flattened volar surface of the finger as an end result.

#### DRAINAGE

Incisions should be packed widely. Where through and through drainage is used rubber dam is preferable. Removal of drains after about 48 hours is advisable. In this way subsequent painful dressings are avoided and the incision does not have a tendency to close as long as there is necrotic tissue at its bottom. In some instance an adequate incision without drainage is all that is necessary.

#### THE POSTOPERATIVE TREATMENT

A dry dressing tends to control bleeding. The finger is partially elevated by means of a sling. An active arterial hyperemia is produced as soon as possible by means of hot soaks, leaving the bandage on and using either sterile saline or sterile water. The treatment is carried out every 3 to 4 hours for 15 minutes for the first 3 days. If the tissues become too macerated the number of soaks is decreased. Dead epithelium is removed as soon as possible. If adequate and proper incisions are made a narcotic is usually not necessary. A granulating surface requires the application of ordinary surgical principles to insure epithelialization.

#### POSTOPERATIVE COMPLICATIONS

Any of the pre-operative complications may occur postoperatively and would have to be treated accordingly. Osteomyelitis of the terminal phalanx is perhaps the most frequent. Gentle removal of the sequestrum

after a complete line of demarcation has formed is the treatment. The sequestrum may be composed of cortical bone alone or a combination of cortex and medulla. In many instances a definite involvement of bone does not yield a sequestrum if adequate drainage is instituted. Under no circumstances should diseased bone be cut away.

#### POSTOPERATIVE SEQUELÆ AND END RESULTS

The scar as a rule becomes almost invisible and movable on the underlying structures.

An epithelial cleft is due to an infolding of epithelium in the line of incision and probably occurs more frequently if drainage has been prolonged and if the horseshoe incision has been used. With loss of tissue from the closed space and with scar tissue pulling on the edge of the incision the epithelium has a tendency to invert itself. Excision of a wedge including the cleft and approximation of the raw surfaces usually suffices to correct this condition. The major part of an epithelial cleft may be almost flattened out by continuous use of the affected finger over a period of years. Clubbing of the finger is usually associated with an incurvation of the nail and is found most frequently following an osteomyelitis. It resembles very closely a hypertrophic osteoarthropathy.

Numbness may be persistent for months or years and is usually worse in cold weather. Tactile sensation may be diminished for a like period of time. Sometimes the finger is colder and bluer than the others; this is especially marked in cold weather.

With necrosis and separation of fat and connective tissue or bone the volar surface of the finger assumes a flattened appearance. For this condition Kanavel (3) recommends a fat transplant. A stubby and shortened finger may result from sequestration even when there has been partial or almost complete regeneration of the phalanx. The last will depend upon the amount of periosteum and medulla from which new bone growth can take place. Periosteal regeneration alone is apt to produce a minimum amount of new phalanx while under the most ideal conditions the terminal tuft is very rarely found to appear again.

# CONCLUSIONS

1 In order to avoid confusion the condition under discussion is best called the distal anterior closed space infection

2 The anatomy has a distinct bearing on the pathology and treatment

3 The infection as observed in a general hospital occurs most frequently in the second third and fourth decades and is about equally divided between the sexes

4 A puncture is the most important etiological factor

5 The hæmolytic staphylococcus aureus is the chief infecting organism

6 Local tenderness is the most important sign

7 Complications depend upon direct extension and lymphatic drainage

8 The treatment is surgical and it is based upon the unique anatomy of the distal anterior closed space

9 A general anæsthetic is preferable

10 Diseased bone demonstrated clinically and by the X ray does not necessarily sequestrate especially if adequate surgical drainage has been obtained A line of demarcation in dead bone is the indication for sequestrotomy Cutting away or curettage of dead bone is contra indicated

11 Removal of drains after about 48 hours is preferable

12 The average period of disability is about 3 weeks

13 In cases treated early and well the end results are good An epithelial cleft clubbing and stubbing of the finger incurvation of the nail sensory disturbance and loss of substance

may result In cases in which the diaphysis of the distal phalanx has been removed or absorbed a distorted phalanx usually results with absence of a real terminal tuft

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# THE ACTION OF MERCUROCHROME UPON FOCAL INFECTIONS IN GUINEA PIGS

## AN EXPERIMENTAL STUDY

B J I S A N N E R M D A D J H H I I I M S B L T I M E  
F m h J m B h B dy t l l l J h H p k H p t l

THE object of this study has been to determine the relative rates of healing of focal infections in guinea pigs. Four series of animal were used: 1 set of untreated controls and 3 sets treated with mercurochrome: one locally with applications of 1 or 2 per cent of the drug; another intraperitoneally; and a third intravenously with 1 injection of 5 milligrams per kilogram of body weight.

As is well known it is difficult to infect guinea pigs locally with the common pyogenic organisms pathogenic for man. We found however that by adding a small amount of aleuronat in the form of a dry dough infections could be obtained regularly with many different organisms. An incision was made about 1 centimeter in length down to the peritoneum along the midline of the shaven abdomen of the guinea pigs. By means of blunt dissection pockets were then made about 1 centimeter in width on both sides of the incision. Into these pockets small crumbs of aleuronat dough were inserted and the whole lesion bathed with an 18 hour broth culture of the organism by means of a tuberculin syringe care being taken to reach the innermost borders of the pockets but not to penetrate the peritoneum. After 48 hours of incubation abscesses had invariably formed. These were purulent and the lesion elevated from  $\frac{1}{2}$  to 1 centimeter above the surrounding skin. Bacterial counts of smears of the pus from these lesions usually showed 100 or more bacteria per microscopic field the organism inoculated predominating. However secondary invaders were also found as no attempt was made to protect the lesions in any way. Reserving one third or one half of each group for untreated controls the remainder were treated as desired. Observation consisted in gross examination of the lesions and in counting the bacteria in smears from the pus. The animals which received treatment had daily applica-

tions of 1 or 2 per cent aqueous solution of mercurochrome. Intraperitoneal injections of 5 milligrams per kilogram body weight a 1 per cent solution being used were made daily. The intravenous treatment was given by exposing the external jugular which was injected with a 1 per cent solution of the drug. As a fine needle was used ligation of the vein was not necessary. The skin incision was closed with fine black silk stitches.

Eight groups of animals have been studied excluding the 2 groups of untreated animals used to determine the course of the infection.

(GROUP III) The 7 animals in group 3 were inoculated described the culture being staphylococcus aureus. Three animals were held as control and 4 were given local applications of 1 per cent mercurochrome. One control died on the fifth day when the wound count showed 100 or 100 bacteria per field. The lesions in the other control remained but the same animal the count remained at 100 or greater per field. One of these animals became greatly emaciated and died the ninth day. The third control showed a count of 100 until after the thirteenth day longer after the wound of the treated animal had been sterilized or healed. The third control the gradually improved and the lesion was healed on the twentieth day. The treated animal all of which began with the same type of lesion and degree of infection as the control that with counts of 100 bacteria per field presented an entirely different picture. For the first days the counts remained the same but in 3 of the 4 cases the lesions were much better after the first treatment and while the counts were still high. The lesions continued to improve steadily and all healed. From the third to the fifth day of treatment there was a startling drop in the number of bacteria a reduction of from 100 to under 100 organisms. From that time on the drop continued rapidly reaching zero on from the seventh to the tenth day. 1 of the 4 treated animals healing was complete by the ninth day in by the twelfth and in 1 by the thirteenth.

GROUP IV Four pigs received the same inoculation as those of Group III but on a different date. Two animals were reserved as control and 2 were treated locally with 1 per cent and 1 with 2 per cent mercurochrome. In this group the wound counts paralleled those of Group III. The number of

organisms in the controls remained high while those of the treated animals dropped from over 100 to 8 and 15 per field after 3 treatments and then fell rapidly to zero which was reached the day after the sixth dose healing being complete on the eleventh and twelfth days (pigs Nos 1 and 13).

The count in the controls remained high and the lesions did not heal in No 15 until weeks after the last of the treated animals and in No 14 although healing was complete soon after the treated animals the count remained high much longer in the control.

GROUP V Seven pigs were inoculated with the same organism and in the same way as Groups III and IV. One pig No 17 died leaving 3 controls and 3 animals which received local treatment with 1 per cent mercurochrome. The count in No 21 remained over 100 until the eighth day. Healing was complete by the thirteenth day. The second control No 2 had a count of 100 until eleventh day when it suddenly fell off and healing was complete by fourteenth day. The third control No 20 had a smaller number of organisms throughout the infection the count remaining after an initial drop the fourth day around 20 until the seventh day when it again dropped showed a secondary rise and finally was completely healed by the thirteenth day. The 3 treated animals all began with counts of over 100 per field. No 19 dropped after the second treatment. No 18 after the first with a secondary rise. In No 16 the count remained high until the day after the fourth treatment that is the seventh day of infection when it fell off suddenly and healing was complete the fourteenth day the other treated animals being healed by the eleventh day. The treated animals had much larger abscesses than did the controls.

GROUP VI This consisted of 1 animal inoculated as before described. Four of these were held as controls 4 were treated locally and 4 intravenously. The counts in the 4 controls remained up that is 100 per field. One pig No 34 died the twelfth day in great emaciation another No 3 showed pus the twelfth day with a high count and did not heal until the sixteenth day. The third control No 33 showed a drop in count the sixth day and was healed by the fourteenth day. The fourth control No 32 with a high count until the seventh day was also healed by the fourteenth day. The 4 animals which received local treatment were swabbed with 1 per cent solutions. In only 1 case No 30 did the count remain high after the first treatment and in this it had dropped to zero by the sixth day. The 3 other animals so treated No 27 No 28 and No 26 showed drops in the counts after only 1 treatment from over 100 per field to 35 21 and 2 per field respectively with a characteristic thinning of the pus which became almost watery within 24 hours of the initial treatment. The counts in these animals dropped rapidly to zero and 1 animal was entirely well by the eighth day the others showing marked improvement and final healing in 1 case on the ninth day and in the other on the twelfth. The 4 animals given intravenous treatment in this series all began with counts

of 100. In 2 cases Nos 24 and 31 the count remained high until the fifth day that is the second day after treatment in there was a drop by the day after treatment in 1 case No 25 to 5 and in the other No 29 to 4 organisms in 10 fields.

In all of the animals treated intravenously there was a typical change in the lesions consisting of a flattening out of the abscesses followed by a rapid drying and quick healing 1 being well by the seventh day and 1 by the eighth 1 by the ninth and 1 by the twelfth a better record than that shown by the animals of the same and other groups treated locally.

GROUP VII Twelve pigs were inoculated 4 being used as controls 4 given local treatment and 4 intravenous. The result closely paralleled those of Group VI. Although 1 of the controls No 41 showed a drop in the count on the seventh day and was healed by the fourteenth and another No 45 began to drop the eighth day and was also healed by the fourteenth the others continued to show very high counts. Of these 2 pigs 1 No 35 finally started to drop on the tenth day however healing was not complete until the twenty-ninth day. The fourth control No 39 showed 100 organisms per field through the twentieth day long after the other animals were healed and the lesion did not heal until the forty-second day.

Of the 4 animals in this set treated locally with daily applications of a 1 per cent aqueous solution of the drug No 35 and No 42 showed a drop in the count after the first treatment and the other 2 No 43 and 44 after the second treatment. The counts remained very low and healing was complete in No 42 by the eleventh day in No 36 and No 43 by the twelfth day and in No 44 by the thirteenth day.

The best results in this set however were obtained with intravenous treatment consisting of 1 intravenous injection of 5 milligrams per kilogram body weight. As in the locally treated pigs in 2 cases No 37 and No 46 the count fell off the day after treatment the other 2 No 38 and No 40 dropping the next or fifth day. Healing however occurred much more rapidly than in the series treated locally. No 37 and No 46 being healed by the eighth day. No 38 by the ninth day and No 40 by the tenth day.

GROUP VIII Twelve pigs were infected and 4 used for controls 4 treated locally 3 with 1 per cent solution and 1 with a 1 per cent solution and 4 pigs were treated intraperitoneally with daily injections of 5 milligrams per kilogram body weight. The controls continued to show counts of over 100 bacteria per field until the eleventh day when the counts in one of them No 5 began to drop healing being complete in this case the twentieth day. Control pig No 56 healed in the same time as No 52 but its count did not begin to drop until the thirteenth day. The pigs treated locally however all showed a drop in count by the fifth day 3 being healed by the ninth day and 1 by the tenth. Of the 4 pigs treated intraperitoneally 3 showed a drop in count on the fifth day the fourth pig a drop by the sixth day. Healing was rapid No 53 being healed by eighth day. No 40 by ninth No 58 by eleventh and No 50 by twelfth.



TABLE I—SUMMARY OF THE INCIDENTS

[illegible]

[illegible]

In view of the good results obtained by intravenous treatment an additional group has been studied being divided so that half of the animals were held for untreated controls and half treated with one intravenous injection of 5 milligrams per kilogram body weight of drug given on the third day after inoculation and abscess formation. In this group in which the lesions were very large 1 of the controls died on the fifth day. With the other 4 controls one was well by the thirteenth day and 3 by the nineteenth day. Of the 5 animals treated with 1 intravenous injection the counts in 3 had dropped within 47 hours after treatment and in the fifth by the eighth day. Healing was complete in the treated animals in 1 case by the tenth day in 1 by the eleventh in 1 by the thirteenth in 1 by the seventeenth and in 1 by the nineteenth. The resolution of the lesions was slower than in the other series treated intravenously but the lesions were correspondingly larger.

## SUMMARY

1 Guinea pigs with abscesses have been treated with mercurochrome locally intra peritoneally and intravenously

2 The animals treated locally as compared with untreated controls showed a prompt and rapid drop in the wound counts with healing before the controls

3 The animals treated intraperitoneally also showed a rapid drop in counts and healing more rapid than in the sets treated locally.

4 The intravenous injection of 5 milligrams per kilogram body weight also caused a prompt and rapid drop in count in some cases quicker than in the animals treated locally

## CONCLUSION

Mercurochrome used locally and intravenously was found to be of benefit in treatment of infected wounds in guinea pigs. It was observed that healing after intravenous treatment was much better than when no treatment was employed and fully as rapid as with local treatment. Since in the animals treated locally there was obviously a much stronger concentration of drug in the lesion than could possibly reach it by intravenous injection these experiments confirm other studies showing that intravenously the drug acts indirectly as well as directly.

EXTRA-UTERINE PREGNANCY LITHOPÆDION<sup>1</sup>

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15 25 M J Clin

THE term lithopædion is applied to a fetus which has been retained within the maternal abdomen and of which the tissue have become more or less completely infiltrated with calcium salts.

In the Mayo Clinic 9 lithopædions have been observed in the 4 year period from 1903 to 1906 inclusive. Eight were observed at operation and 1 was removed at necropsy from the abdomen of a woman who had died from carcinoma of the oesophagus. During this same period 445 operations were performed for extra uterine pregnancy.

## LITERATURE

The literature on the subject is not extensive but it covers a period of nearly 5 centuries. In the early days the discovery within a woman's abdomen of such a hard stone was having the form of a child excited wonder and speculation and was even viewed at times with considerable awe. Bainbridge quotes an interesting account of the first case of which we have any record. He says: "Israel Spach in an extensive gynecologic work published in 1557 figures a lithopædion drawn *in situ* in the case of a woman with her belly laid open. He dedicated to this calcified fetus which he regarded as a reversion the following curious epigram in allusion to the classical myth that after the flood the world was repopulated by the two survivors Deucalion and Pyrrha who walked over the earth and cast stones behind them which on striking ground became people. The epigram reads as follows: Deucalion cast stones behind him and thus fashioned our tender race from hard marble. How comes it that nowadays by a reversal of things the tender body of a little babe has limbs nearer akin to stone?"

Kuechenmeister reviewed the literature from 158 to 1880 and noted 45 cases which he believed to be authentic. To these he added 1 of his own. He studied these cases in detail and proposed a classification of lithopædions which is still generally accepted. Strauss

Bainbridge, D'Aunoy and King and others have reviewed the later literature (Table I) and we have been able to find records of 13 additional cases (Table II) not included by any of these authors making a total after deducting the duplicates of 174 cases reported in the literature from 1582 to 1906 inclusive.

In 1881 Leopold reported some experimental work to show the fate of rabbit fetuses removed from the maternal uterus and left in the abdomen. He placed embryos 2.5, 5 and 8 centimeters in length in the abdominal cavities of adult rabbits. In some instances he used the fetus alone and in others the entire embryo with its membrane intact. There was usually no reaction on the part of the host except in those cases in which peritonitis developed. By the second day the 2.5 centimeter fetus had almost completely disappeared and by the ninth or tenth week the 8 centimeter fetuses had been reduced to a few remnants of the paws, the integument and the skeletal system. In the presence of infection the process of destruction and absorption progressed much more rapidly. If the umbilical cord was ligated absorption was slower.

## INCIDENCE

The incidence in the Mayo Clinic series of 9 lithopædions in 445 cases of extra uterine pregnancy (2 per cent) is a little higher than has been previously reported. Schumann quoted the incidence at from 1.5 to 1.8 per cent but he believed the percentages to be too high. It is evident from the number of cases that have been reported that the condition is unusual even more so now than formerly because we have learned to recognize the presence of a retained fetus and to remove it surgically long before it is possible for a lithopædion to develop.

## CLASSIFICATION

Kuechenmeister pointed out that calcification in the products of conception may not

TABLE I—SUMMARY OF CASES REPORTED  
IN THE LITERATURE

R e p o r t e d b y	P e r i o d	C a s e s
Kuechenmeister	1583-1880	47
Strauss	1580-1900	46
Bainbridge	1900-1912	37
Clark (no details given)	1880-1897	19
D'Unoy and King	1912-1922	14
Krauss	1903-1922	26
Additional cases (Table II)	1900-1926	14
		203
	Duplicates	9
	Total	174

be entirely limited to the fetus but may also involve the membranes and the placenta or may be entirely limited to the latter structures. On the basis of these variations he proposed their division into three groups:

1. Lithokelyphos (stone sheath or egg shell) in which the membranes alone are calcified and form a hard shell surrounding the fetus. The fetus may undergo only slight change or it may be completely skeletonized but it is not involved in the process of calcification. Kuechenmeister believed this to be the most common type and the result of the membranes remaining intact around the fetus at the termination of pregnancy.

2. Lithokelyphopædion (stone sheath child) in which both the membranes and the fetus are calcified. The amniotic fluid has escaped or has been absorbed at the time of or soon after the termination of pregnancy and the fetus remains partially or completely surrounded by the membranes.

3. True lithopædion (stone child) in which the fetus is infiltrated with calcium salts and in which the calcification of the fetal membranes is negligible. This type he believed resulted when the fetus escaped unattached into the abdominal cavity, the membranes being either left behind or closely wrapped about the fetus.

While this classification has no clinical value it provides a convenient method of grouping specimens. The confusion resulting from the double use of the word lithopædion in referring to the general group as well as to the third group could be avoided by substituting the word lithotecnon when referring to the third group, the true lithopædion of

TABLE II—ADDITIONAL CASES REPORTED  
IN THE LITERATURE

R e p o r t e d b y	A g e a t t i m e	S e x	A g e a t t i m e	O t h e r p a r t s	
				P	S b q u e n t
A l l	3	4	6	3	
A t y	05	3	9		
B g	45	4		?	?
B i l l i t	49	4	5	(m g )	
B e g	54		9		
B q h y	5		5		
L e g	?	4	9		
M c m k	73	5	9		
M	4		6		
M w l l	55	?	?	8	
P l k m	5	5	?	7	
S p	75	46	9		3
S p	67	6	5		
T t	46	6	5		

Kuechenmeister in which the fetus alone is calcified.

In 115 cases reviewed in the literature some attempt has been made to group the specimens according to this classification. In 53 cases (46 per cent) they are described as true lithopædion or lithotecnon in 49 cases (46 per cent) as lithokelyphos and in 13 cases (11.4 per cent) as lithokelyphopædion. These figures at best are inaccurate because the cases have been described by a large number of observers and frequently the selection of the classification depends on the thoroughness of the examination of the specimen or on personal opinion.

# MAYO CLINIC CASES

CASE 1. A woman aged 4 years presented herself at the clinic with obstruction of the esophagus from extensive carcinoma. She had 2 children, aged 5 and 9 years respectively. Since the birth of the last child she had had what was thought to have been a miscarriage at about 3 months.

The patient died shortly after admission to the hospital. At necropsy the left ovary was found to be cystic and enlarged. In the fimbriated end of the left tube was a mass 4 by 3 by 3 centimeters which on section produced a grating sensation. This proved to be a fetus 6 centimeters long. Microscopically the soft tissues including the lungs contained scattered deposits of calcium salts. The specimen was classified as early lithotecnon or true lithopædion.

CASE 2. A woman aged 30 years had had 2 miscarriages the first at about the third month soon after marriage. Following one of these 19 years previously there had been slight bleeding from the vagina

for a month and during this time she had had several sinking spells and was ill for a week. She gradually recovered except for painful defecation which persisted for 5 years. She complained chiefly of bloating and leucorrhœa which had been present for 3 years.

The uterus enlarged firm and irregular and a hard nodular mass moderately tender was attached posteriorly to the cervix and extended well up into the abdomen. The possibility of fibromyoma was considered and exploratory laparotomy advised. At operation multiple fibromyomata in the uterus and a calcified mass adherent to the right side of the pelvis were removed. Appendectomy was also performed. The patient had an uneventful convalescence but a postoperative hernia developed which was repaired 3 years later. A cyst of the left ovary with the corresponding tube which was chronically inflamed was also removed at this time. Six years after the operation there had been no subsequent pregnancies. Menstruation had been normal and general health good. There had been some leucorrhœa.

The specimen (Fig. 1) consisted of a calcified mass 5 by 3 by 3 centimeters in which several long bones, the ilium and some cranial bones could be identified. There was no trace of the placenta or chorion or other membranes. The specimen was classified lithotecton or true lithopædion.

CASE 3. The patient aged 44 had been married 21 years, had had 15 children, 3 living, the youngest aged 9 years and miscarriage at about 2 months. She complained of heartburn and abdominal discomfort which had started during the last pregnancy. Occasionally pain in the upper quadrant had been noted with in the last 6 weeks.

Examination disclosed marked uterine prolapse and extensive old lacerations of the perineum. A small mass which was firm and tender occupied the posterior fornix. At exploration chronic cholecystitis with cholelithiasis was found and cholecystectomy was performed. An encapsulated mass adherent to the sigmoid adnexa and surrounding structures was removed from the left side of the pelvis. Appendectomy and a Kocher operation for prolapse were performed separately. Convalescence was uneventful. Thirteen years after the operation the patient's general health was good but she complained of severe pelvic symptoms secondary to recurrent uterine prolapse.

The specimen (Fig. 2) consisted of a firm calcified mass about 4 centimeters in diameter composed of the fused and calcified remains of a fetus in which the cranial and some of the long bones could be identified. Nothing suggested the fetal membranes could be recognized. The specimen was classified as lithotecton or true lithopædion.

CASE 4. A woman aged 31 years who had been married 10 years had a child aged 5 years. Four years previously she had had a miscarriage. Since then she had felt weak and run down and had been aware of sensation of weight in the pelvis. Menstruation ceased for 11 months following the miscarriage and then occurred regularly.

A hard, rough, tender mass posterior to the uterus was palpated. On bimanual examination crepitation could be elicited. A diagnosis of a dermoid or a calcified pelvic tumor was made and exploratory laparotomy advised. An infected lithopædion closely adherent to the right ovary, the sigmoid and the small intestine was removed together with a hæmatosalpinx from the left side. Appendectomy was performed separately. The patient died on the eighth day from intestinal obstruction and diffuse peritonitis.

The specimen (Fig. 3) was 8 centimeters in diameter and consisted of a hard shell with walls from 0.8 to 1.0 centimeter thick representing the calcified fetal membranes. Within this shell was a completely skeletonized and partially disarticulated fetus together with some pus and necrotic material. The bones of the skeleton were unusually hard and brittle. Microscopic examination of the wall revealed fibrous tissue infiltrated with calcium salts. The specimen was classified as infected lithopelyphos.

CASE 5. A woman aged 25 years had been struck on the back by her husband 19 months previously when she was 3 months pregnant. Soon after this she became aware of a mass in the right lower quadrant and bleeding occurred irregularly and profusely for a time. She was sick for about 7 months then menstruation recurred and the abdominal mass increased in size. Subsequently there had been occasional bloody attacks and slight tenderness in the right side of the abdomen.

A hard mass was palpated in the region of the right tube. The uterus was in good position and normal in size. At exploration a large calcareous mass adherent to the small intestine was removed from the right side together with the corresponding tube and ovary and the appendix. Convalescence was uneventful.

The mass consisted of a fetus partially encapsulated by the remnants of the membranes and with the placenta and cord attached (Fig. 4). The placenta was unusually firm and macroscopically showed areas of hyalinization and calcification. The fetus was fairly well preserved but it was dehydrated and shrunken. Microscopic sections of the cord showed numerous patent vascular channels many of which had thickened walls. The soft tissues of the body of the fetus were well preserved and were not calcified. The specimen was classified as early lithopelyphos.

CASE 6. A woman aged 5 years had a child aged 30 years. Sixteen years previously menstruation had ceased. The abdomen had enlarged. Secretion had appeared in the breasts and movement was noted in the abdomen. After 7 or 8 months she experienced slight pain in the left side and the abdomen gradually became nearly normal in size. Subsequently the patient regained health and menstruation was normal until 8 months before admission when it became irregular. There had been frequency of urination during the last 6 months. The patient had not lost weight. There was a hard nodular mass in the pelvis a little to the left



FIG. 1. Case 2. Lithotecnon retained in the abdomen 19 years.



FIG. 2. Case 3. Lithotecnon removed from the left side of the pelvis.

of the uterus. Roentgenograms showed the outline of a fetal head in the left side of the pelvis with a dense oval shadow lying across the pelvis and extending up to the level of the fifth lumbar vertebra. Cystoscopic examination revealed diffuse cystitis. A pre-operative diagnosis was made of lithopædion and a laparotomy was performed. The greater part of the fetus was found free in the peritoneal cavity, but it was partially adherent to the sigmoid and omentum. The head was contained within the folds of the broad ligament on the left side. The mass was removed and the uterus, which was adherent and retroverted, was dissected free and fixed to the anterior abdominal wall. The gall bladder contained multiple small stones and was removed 17 days later. Convalescence terminated uneventfully. Four years after the operation the patient was enjoying excellent health and was working hard.

The specimen (Fig. 5) consisted of a partially skeletonized fetus with the cord and remnants of the placenta attached. The membranes partially surrounded the fetus and were closely attached to it at several points. Microscopically they showed hyalinization and calcification. The soft tissues of the fetus were shrunken, absent in places, and there was gross and microscopic evidence of calcification. The specimen was classified as lithokelyphopædion.

CASE 7. A woman aged 26 years had 1 child aged 11 years. She had not had miscarriages. About 1 years before the examination menstruation had ceased and pain in the back and several fainting spells occurred. The abdomen increased in size but she was not aware of any movements as with the former pregnancy. At term she experienced labor pains and passed small pieces of tissue but no fetus. Subsequently the abdomen gradually decreased in size and menstruation reappeared, but backache persisted.

A movable mass was palpated in the lower part of the abdomen. It appeared to be attached to the uterus. Roentgenograms revealed the outline of a

large fetal head and a long dense shadow lying transversely in the pelvis. Old extra uterine pregnancy and rupture were diagnosed. The fetus was removed at laparotomy. Convalescence was uneventful.

The specimen consisted of a degenerating fetus of about 8 months development with the cord and placenta attached. The latter was firm and on section produced a grating sensation. Microscopically there was extensive hyalinization and the tissues were infiltrated with calcium salts. The membranes were thickened and somewhat cartilaginous. They partially surrounded the fetus and were closely attached to it at several points. On microscopic examination the structures appeared to be fairly well preserved; there were deposits of calcium salts throughout, especially marked within the vascular channels. The soft tissues of the fetus were firm and did not show gross or microscopic evidence of calcification. The specimen was classified as lithokelyphos.

CASE 8. A woman aged 24 years had missed 8 successive menstrual periods 4 years previously. She had been confined to bed during practically all of the first 4 months but her health improved and she was able to do housework during the latter 4 months. With the subsequent return of menstruation she gradually regained her health except for moderate dull pain and some soreness in the right lower quadrant. Five months before examination she again thought she was pregnant. There was severe pain in the lower part of the abdomen and she was confined to bed on several occasions. Subsequently menstruation reappeared, health was regained, and all evidences of pregnancy gradually disappeared.

The cervix was small and the fundus of the uterus was moderately enlarged and retroverted. A mass about 10 centimeters in diameter was palpated in the left side of the pelvis and another about 3 or 4 centimeters in diameter was palpated in the right



be determined was about 7 months. It appears that only the more mature fetuses undergo this transformation.

Leopold has shown experimentally that an immature fetus free in the abdomen of a rabbit will rapidly undergo absorption. A similar fate awaits the immature fetus which enters the abdomen of a woman on the termination of extra uterine pregnancy.

It is impossible to obtain reliable data regarding the types of extra uterine pregnancy that are most likely to result in the production of lithopædion. In general it is the type in which the fetus is most likely to develop to near term and while this may occur in practically every type it is more common in some than in others.

In tubal pregnancy advanced development of the fetus within the tube has been observed but rarely. Pregnancy is usually terminated before the third month except in the rare instances in which secondary tubo ovarian, tubo abdominal, intraligamentary or abdominal implantation saves the fetus and permits it to develop to term. The same is true in the interstitial type of pregnancy. Primary abdominal and ovarian pregnancies are relatively rare but they reach advanced development oftener than do tubal pregnancies. Besides extra uterine pregnancy it is conceivable that a mature fetus might enter the abdomen as the result of rupture of a pregnant uterus and the mother recover without surgical interference. This accident however is usually fatal unless surgical measures are promptly instituted and then the fetus is removed from the abdomen.

The fetus that continues to develop to maturity will die from deficient nutrition unless delivered by abdominal section. If it remains in the abdomen it will be disposed of in some manner by the maternal organism.

Mummification, adipocere and various types of fatty change have been described in these retained mature fetuses but it is not known if these changes are entirely different processes or merely successive steps in the production of lithopædion.

The exact chemical process by which calcium is deposited in the tissues here or else where in the body is not well understood.



Fig. 4. Ca e<sub>3</sub>. Early lithopædion retained in the abdomen 9 months.

MacCallum states that there seems to be something peculiar about tissue living or dead which gives them the power to catch up the calcium from the circulating fluid and hold it firmly in solid form. However no precise and satisfactory chemical explanation has been offered.

The diagnosis of lithopædion can practically always be made from the history but its presence is frequently not recognized because the condition is not borne in mind and the various events in the history are not correlated until the diagnosis has been made at operation. The symptoms may be divided chronologically into four groups corresponding to the successive stages in the development.

1. *The onset of the pregnancy.* In practically every instance the patient gives a history of pregnancy which has been atypical in some respects depending on the type of pregnancy responsible for the production of the fetus. The symptoms may be those of ruptured tubal gestation which continues as a second





appears much more distinctly than in a normal pregnancy because of its increased density and because it is not surrounded by amniotic fluid or the thick uterine walls. The fetus may also occupy an abnormal position and may assume an abnormal attitude or be completely disarticulated. Other tissues besides the skeleton which have become infiltrated with calcium salts will produce an extraskel-etal shadow of varying density and outline depending on the extent of the calcification and the portions of the products of conception involved. Such observations in a patient who presents none of the symptoms of pregnancy or who has passed through the menopause or in whom a normal uterus can be outlined are sufficient evidence on which to base the diagnosis of lithopædion.

The conditions with which lithopædions are most frequently confused are calcified fibromyomata and ovarian dermoids. In the presence of a hard mass in the pelvis even when the history of a miscarriage or a somewhat atypical pregnancy is given either of these diagnoses may easily pass unquestioned unless the possibility of lithopædion is borne in mind. It should be remembered however that fibromyomata when they become sufficiently calcified to be confused with a lithopædion rarely produce symptoms and diagnosis should be made with caution when symptoms are present.

Ovarian dermoids may be a source of confusion except when they are bilateral. Previous miscarriage or atypical pregnancy is not an essential part of the history of ovarian dermoid although Kouché found that in 63 per cent of the cases in his series there was a history of previous pregnancy or miscarriage. Roentgenograms of the pelvis always furnish positive data which establish the presence or absence of lithopædion or calcified fibromyoma and the presence of teeth will establish the diagnosis of dermoid.

# TREATMENT

It appears from Kuechenmeister's article that the first case to be successfully treated by abdominal section was that reported by the barber surgeon von Weinhardt in 180. Since then the relative frequency of the surgically treated cases has steadily increased.



FIG. 6. Case 5. Lithokelyphopædion retained in the abdomen 4 years.

The treatment is now practically always considered to be surgical unless the patient is advanced in years and free from symptoms or unless operation is contra-indicated for some other reason. When the calcareous mass is more or less free in the abdominal cavity its removal is simple but when bound down to the neighboring organs by a dense mass of adhesions or if it has ruptured into some viscus and the whole mass is infected its removal immediately becomes more difficult and attended by some hazard. In some instances the uterus and adnexa are so closely adherent to the mass that it is necessary to remove them also. When the bladder or the intestines are closely adherent to the mass it frequently happens that partial perforation has already occurred and great care must be exercised in dissecting these organs free to guard against completion of the perforation or when this is unavoidable to recognize and repair it. The raw surface which remains is frequently extensive and may be the cause of the formation of adhesions and intestinal obstruction.

# PROGNOSIS

A lithopædion may not cause symptoms and its presence may be unsuspected until it is found at necropsy after the patient's death from some other cause. In more than 60 per cent of cases however symptoms attributable to the presence of the lithopædion develop after a period of quiescence of from 2 to 30 years. The symptoms are usually mild at first and may become more severe and be attended by marked weakness and emacia.



## CENTRAL DISLOCATION FRACTURES OF THE ACETABULUM

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SINCE 1778 when Henricus Allison (1) first reported a case of fracture of the acetabulum there have come to the authors attention fewer than 50 authentic cases of penetrating fracture of the acetabulum with central dislocation of the head of the femur. The condition has been described by different writers under various and cumbersome titles. Many of the cases were diagnosed only clinically and were unconfirmed by subsequent X-ray operation or autopsy findings. Vaughan has covered the subject well. Reporting a case in a comprehensive review of the literature in 1911 he was able to find only 26 positive and 39 doubtful cases. Woerner (31) in 1907 collected all reported cases—41—but rejected 25 because the diagnosis was not substantiated. Since then Kellogg Speed has reported 2 cases, Lage and Bristow 1, Cotton 5, Kyran 1, Coley 1, Peet 1, Kleinberg 3, and Royal Whitman 3 personal cases and mentioned 5 others that came indirectly to his attention. Fuller's series is analyzed by Vaughan. Few writers have reported more than 3 personal cases. In

this article the senior author reports 5 personal and 10 other cases from the Surgical Service of the University of Pennsylvania Hospital.

The diagnosis is made essentially by X-ray examination. A careful study of the 15 reported cases enables the authors to confirm the two types described by various authorities and to point out that the two types are but relative stages (complete and incomplete) of perforating penetrating or bursting fractures of the acetabulum. Fractures of the acetabulum may be divided into three groups:

1. Fracture of the rim (Figs. 1 and 2).

Radiating fractures of the acetabulum including fractures of the floor and epiphyseal separation of the floor of the acetabulum (Fig. 3).

3. Penetrating fractures with or without intrapelvic displacement of the head of the femur (Figs. 4 and 5).

Cotton describes two types as smashing (radiating) and perforating (or penetrating). The difference between the two from an etiological standpoint is probably but a difference in the



Fig. 1. Case 8. Fracture of the rim with no displacement of the head at the time of the examination. Patient fell on the trochanter.



Fig. 2. Case 14. Fracture of the rim. Note that there is the first degree of displacement of the femoral head. Direct trauma.

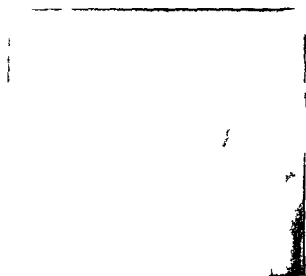


Fig 3 C o R l t f t f th tab l m  
N t th l f f th f mu i th l pe lat n th  
th pp r p t l f th j t u f f d l m



Fig 4 C I n t at (l t n) fr ctu f th  
a tal l N t th f r m nt d e t the p l  
t h a l f d l f m l h d

amount of violence. In one case (Fig. 2) a certain amount of violence caused a marking of the floor of the acetabulum in an adult or an epiphyseal separation in the young. In a second case (Fig. 3) a greater amount of violence caused a bursting of the radiating fractured fragments and in a third case (Fig. 4) where the violence was still greater the

head of the femur was forced through the opening caused by the preceding fracture pathology.

In reality then there are three stage or degrees namely first degree smashing or radiation second degree bursting of fragments or separation third degree perforation penetration or central dislocation of the head



Fig 5 C B lat l f t r f th t l l m  
th fir t d g p t t the l f t d d th d  
d g e p t t d l t th ht



Fig 6 C 9 l l lt N te th l plac d f  
m ts f th t l ula fl b t tle f m l h ad s  
l

of the femur into the pelvic cavity. The latter stage may vary from an impaction of the femoral head into the acetabular opening to complete dislocation with the head of the femur resting upon the sacrum.

### ETIOLOGY

The early literature and inaccurately reported cases then lead to the inference that the fracture and subsequent dislocation occur from violence to the acetabulum transmitted through the long axis of the femur by the neck and head of the femur. Falls from a height upon the feet probably may cause a fracture of this type but most cases that have been carefully studied (Moore, Whitman, Coley, Kleinberg) show that direct violence upon the great trochanter is the usual etiological factor. Vireaux claims to have produced experimentally fractures of the acetabulum by violence through the femur without adduction or abduction. Katz likens the production to the jamming of a hammer or axe handle through its own head by striking the head of the handle with great violence. Kroenlein has reported a bilateral case in which the patient had fallen and landed on his feet. Both femoral heads were found to be driven into the pelvis.

Though the diagnosis of penetrating fractures of the acetabulum and their degree is principally made by X-ray examination, various presumptive signs may warrant one in making a diagnosis before roentgenologic examination is made. Attention is called to the fact that over half of the cases present fractures of other bones of the pelvis which may complicate or obscure the diagnosis. As Cotton points out, when the acetabulum is mashed and the continued violence drives the femur against the pelvic frame after perforation of the femoral head, the pelvic arch almost necessarily must give in (Fig. 3). Ryan has recently reported 73 pelvic fractures (Fig. 6).

### SIMPLE CASES

1. Flattening of the trochanter of the affected side will vary with the degree of central dislocation.

2. Shortening depends upon the extent to which the femoral head is displaced. Vaughan

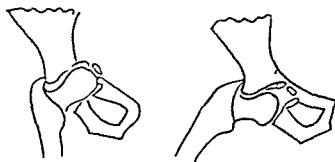


FIG. 1. Polak Whitman Abduction-Reduction. Note that the great trochanter acts as a fulcrum while the femur is abducted by drawing the head of the femur from the acetabulum.

noted in his 26 collected cases that outward rotation of the femur occurred in 11 cases, inward rotation in 1, flattening of the trochanter in 6 per cent and shortening as a rule.

3. Flexion, abduction and external rotation likewise vary in amount or are absent if there is but relatively slight luxation.

4. Obturator pain depends upon fragment injury to or pressure of the femoral head upon the obturator nerve (Fig. 1 to 6).

5. Injuries to the blood vessels and bladder may occur with subsequent hemorrhage and extravasation of urine, though these injuries are more common with accompanying fractures to the bone of the pelvis. Injury to the rectum is rare. Fuller case (No. 3) presented blood in the feces and urine.

6. Crepitus may be present or not depending upon the degree of fracture and of dislocation. Sand reports a case without crepitus, external rotation, elevation of foot or shortening.

7. Tenderness over and pain in the hip on lateral pressure over the trochanter is always present (Kleinberg).

8. Invariably there is a restriction with pain in all movements of the thigh, though cases have walked immediately after injury (Adams) and others have been unrecognized at the time. According to Fuller, motion depends upon the size of the opening in the acetabulum. If the opening is small, motion is greatly limited; if large, the movements are free.

9. Palpation by rectum or vagina of the head of the dislocated femur and the displaced fragments naturally depends upon the extent of pathology in the individual case. Of 26

cases collected by Vaughan the fracture or dislocation was felt by vagina or rectum in 14 cases

10 Occasionally pain and tenderness above Poupert's ligament is noted (Fuller) Neuhof reports a 6-year-old girl with a full Scarpa's triangle

11 Injury to the sciatic nerve with resultant pain and various degrees of paralysis may be noted

12 Since 50 per cent or more of these fractures are complicated by other pelvic fractures associated injuries may manifest themselves according to the individual case. Ecchymosis over the great trochanter, lower abdomen and scrotum may be present with or without tenderness and rigidity of the adjacent hypogastric region. The junior author has noted in a recent case of multiple fracture of the left pelvis and ischium a marked swelling and ecchymosis of the corresponding left half of the scrotum occurring within 18 hours after injury due to trauma of the pudendal blood vessel of that side. Fracture of any and all bones of the pelvis may occur as complications though those of the sacrum and coccyx are extremely rare (Scudder). Injuries to the os pubis and ischium are common (33 per cent and 50 per cent of this series). Sacroiliac infections are probably frequently overlooked while the surgeon's attention is focused upon the primary lesion. The authors cannot recommend too strongly the making of a careful and painstaking examination in co-operation with neurologists when indicated of all fractures of the pelvis. (G. Davis has called especial attention to peroneal palsy (drop foot) which he says occurs in 1 per cent of all pelvic fractures and is due to trauma to the nerve at its origin in the lumbosacral cord as it lies at the pelvic brim.

The nerve lesions most common to pelvic fractures are those of the peroneal, obturator, pudic and sciatic nerves. Morrel Lavallee reports an autopsy in which the head of the femur was found pressing on the obturator nerve and explained the severe pain noted. Adams reports a hyperesthesia of the lower sacral nerves disappearing in 48 hours in a case which was complicated by a sacroiliac luxation.

#### URINARY COMPLICATIONS

In 15 of our cases nerve complications occurred in 5 or 33 per cent. The sciatic was partially paralyzed in 1 case or 13 per cent (Cases 1 and 15). Obturator pain occurred in 3 cases or 50 per cent (Cases 6, 14 and 15). Peroneal paralysis occurred in 2 cases or 13 per cent (Cases 1 and 15). Iudic pain occurred in 1 case or 6.6 per cent (Case 2).

Injuries to the blood vessels, viscera and bladder are most common in cases associated with multiple fracture of the pelvis. The need for immediate surgical intervention little appears in the literature relative to injury to the great blood vessels as these patients die quickly, the bladder not infrequently (extraperitoneally or intraperitoneally) and the urethra may be crushed or lacerated in fractures of the pubis and ischium. Acute retention of urine, hematuria and extravasation of urine are to be watched for. Extravasation will depend on whether the injury to the urethra occurs anteriorly between or posterior to the layers of the triangular ligament.

In the first case the urine usually follows the rectum and reaches the margin of the anus. In the second it dissects between the two layers where it remains until suppuration occurs or the surgeon's knife intervenes. If rupture superficial to the anterior layer of the triangular ligament occurs the urine passes into the scrotum and may mount up to the abdomen between the symphysis and pubic spine. Table I indicates the associated injuries found in the authors' cases.

It would hardly seem possible that fracture of the acetabulum with or without central dislocation could escape unnoticed or be permitted to pass without an X-ray examination. Whitman however observed an opera-

TABLE I — ASSOCIATED INJURIES

	C	P	C
Nath	4		6
Fracture of femur			6
Fracture of iliopectineal ligament	5		33
Multiple fracture of pelvis	8		53
Coccyx fracture	3		6
Fracture of skull			3
Alcoholism			6
Lupus			6
Hematuria	5		33
Ischial			6
Strabismus			6

tion for pelvic tumor which proved to be a previously dislocated femoral head a history and careful physical examination having apparently been dispensed with by the gynecologist. He also saw another patient who walked to the hospital with a cane and who still had pain 7 weeks after injury. Fuller saw a case 11 months after injury with ankylosis and atrophy of all muscles in a young conductor 27 years old who was practically a cripple and whose case had been diagnosed as contusion of the hip. Kleinberg has seen 3 neglected cases and decries the making and diagnosing of roentgenograms by practicing physicians who only incidentally and occasionally use an X-ray machine of their own. One patient came 4 weeks after injury with a cane and pain and the X-ray picture showed an acetabular fracture with little displacement of the head of the femur the man refused treatment. A second had been kept in bed 6 weeks and then permitted to use a cane (with pain) before Kleinberg saw him. Examination revealed atrophy of the leg and the X-ray picture showed a fracture dislocation of the acetabulum with fracture of the os pubis. The third a female had been examined with the X-ray originally and the report was negative. She was kept in bed 5 months with baking and massage then (still with pain) was given a cane. She was seen 1 month later by Kleinberg (7 months after injury). Flexion and adduction were painful and abduction was markedly restricted. The X-ray examination showed a fracture dislocation of the acetabulum with a large intrapelvic bulging calcareous mass. Cotton has likewise seen a case of 33 years duration though the man is quite active despite a stiff hip. Three of the present series were 12 to 30 months old before seen by the attending surgeon. Careful examination of the hip movements and measurements of the lower extremities cannot be overemphasized in all injuries to the pelvis and lower extremities.

#### SEX

Central dislocation fractures of the acetabulum occur more frequently in males than in females as more men are engaged in the industrial trades. Increasing rapid transpor-

tation and automobile accidents may affect either sex. In our service the sex incidence is 80 per cent males and 20 per cent females.

#### AGE

The fractures occur more frequently in early middle life. The youngest of our cases was 20 years old the oldest 58 and the average 38 years old.

#### LOCATION

Kroenlein reports a case of bilateral fracture and one case is included in the authors series. The majority of cases apparently appear (11 to 3) on the left side.

#### INCIDENCE

Though the literature and textbooks would indicate that this condition is a relatively infrequent one the authors find it not at all uncommon. Fifteen cases were seen at the University of Pennsylvania Hospital between 1909 and 1927 at the same time that 10,300 fractures were treated making its occurrence assume the proportion of 1/687 fractures. During this same period 1 other fractures and epiphyseal separations of the pelvis were observed. As 4 of the reported series have occurred during the last 18 months and all were due to automobile accidents it is thought that more fractures of this type may be seen in the future.

#### PRODUCTION

Of 8 cases in the literature in which the cause was mentioned 7 were due to direct violence over the great trochanter and 1 was doubtful. Of this reported series 4 were due to jamming injuries to the hip in automobile accidents to direct force over the hip to crushing violence 1 to a fall on the hip while skating and 6 were caused by falls from a height in which it could not be ascertained what part of the patient's body hit the ground first. Direct violence over the great trochanter was certain in this group in 9 of 15 cases or 60 per cent, of the 7 of 8 cases from the literature 97.5 per cent.

#### TREATMENT

Delayed or non union has not occurred in either the authors or reported cases. The



treatment varies in simple and complicated cases depending upon whether an acetabular fracture with central dislocation alone (46 per cent) or other fractures of the pelvis are likewise sustained (53 per cent). Grave injuries to intrapelvic blood vessels demand immediate operation and transfusion. Ruptures or lacerations of the bladder require immediate laparotomy, suture of the bladder drainage, and a permanent catheter left in place until healing is assured. Laceration of the urethra require perineal incision, repair of the urethra, and the leaving of a catheter in place until healing has occurred.

When due to sacroiliac subluxation nerve injuries should be treated by immobilizing the sacroiliac joint when due to pressure of fragments or a dislocated femoral head they should be treated by reduction of the dislocation and an attempt should be made to correct or change the position of the fragments under anesthesia by flexion abduction or adduction and external rotation of the thigh under the fluoroscope. If the obturator nerve is injured by the femoral head or engulfed in scar tissue or callus formation little can be done other than the administration of palliative treatment. The sooner nerve injuries are recognized the sooner procedures and corrections can be instituted for their alleviation when they remain unrecognized until during or after convalescence little can be done. In peroneal nerve lesion the foot should be supported, massage and electricity should be applied early during fracture healing. One year later if there has been complete division or permanent damage to the peroneal nerve in the lumbosacral cord the peroneus longus may be transplanted into the anterior tibial tendon by the Myer technique (Scudder).

Reduction of the dislocation is best done by closed methods. Ether anesthesia and complete muscular relaxation should be utilized. Lateral (outward) rotation and longitudinal traction under anesthesia may be employed as advised by Cotton and others. Royal Whitman has had very good success in using extreme abduction and lateral traction during which procedure the great trochanter engages upon the acetabular rim or ilium and with the femoral shaft abducted as a long

lever the head of the femur is forced out of the pelvis (Fig. 7). Kleinberg successfully used this method in a case of 7 months duration when lateral and horizontal traction or weight suspension would have been useless. Care should be used to cause no further damage than has already been done as sacroiliac subluxation and fractures of the pubis and ischium may injure nerves, bladder and urethra if manipulated violently. If the dislocation is not reducible open operation is apparently unwelcome (Scudder). In a case (Vaughan) in which closed methods failed open operation resulted in suppuration of the hip joint.

Reduction may be maintained by the use of a plaster spica including the trunk, hip, thigh and leg the lower extremity being abducted and externally rotated. Page and Bristow advise 30 degrees abduction, 0 degrees flexion and 10 degrees external rotation so that the limb will be in the best functional position should partial or complete ankylosis take place. If the condition has been recognized early and treated no ankylosis has occurred in the authors' series or in those cases reported in the literature. Partial ankylosis occurred in Kleinberg's case of 7 months standing but he nevertheless reduced it by Whitman's abduction method. Early motion will of course prevent ankylosis and should be instituted in all cases. In 5 or 6 weeks (Coley) the plaster spica may be cut at the knee, the leg freed and mobilized and allowed to rest in a chair and walking permitted with crutches and later with a cane. The entire cast should be discarded 10 weeks after application if not sooner. Whitman had a recurrence when the spica was discarded after 7 weeks and the patient was permitted to walk. The dislocation was again reduced and immobilization for 10 weeks effected a cure. Length of immobilization in simple cases will depend upon the size of the perforation. Adams used a pelvic cast for only 10 days. Speed advises a plaster spica for approximately 4 weeks in the non-penetrating type of acetabular fracture.

Loepp in a recurrent case used 20 pound extension for 3 months without splints or plaster. Scudder recommends suspension (in a pelvic cradle) and traction. The latter

should be considered in the presence of fractures to other pelvic bones. Fuller favors abduction or adduction traction and counter traction. Simple extension and immobilization with sandbags have likewise been used. As Cotton points out there is no standard treatment. Each case is and should be a law unto itself. Though abduction and weight extension may be sufficient in some cases considering the number of cases with associated fractures the plaster spica with the leg abducted flexed and externally rotated is probably best.

### RESULTS

In the literature the results have varied. In untreated cases in which there is not great penetration a new socket (with use of the joint) may form and give satisfactory function (Speed). There is generally some limitation of motion slight shortening and stiffness of the hip (Scudder Vaughan). Lendrick once saw a middle aged man untreated who later was able to take long tramping trips in German fashion. Autopsy after death from tuberculosis revealed the femoral head driven into the pelvis where a new bony cavity had been formed. Both pubes and ischium had been fractured. An unrecognized case in a young man seen by Fuller caused incapacitation for life. Coley's patient rode a bicycle 7 months after injury.

In the authors series a follow up has been obtainable in only 7 cases 46.6 per cent. Five of this number (Cases 3, 8, 11, 12 and 13) are doing their former work, one (Case 14) lighter work and one (Case 15) is in an asylum with psychosis (due to fractured skull). Three have a slight limp (Cases 5, 8 and 11) and 3 (Cases 1, 13 and 14) show limitation of motion and slight pain (Fig. 6).

### PROGNOSIS

**Recurrence.** Recurrence did not take place in any of the cases here reported. Speed advises resection of the head of the femur if the acetabular opening is large and recurrence continues. Whitman had one recurrence. Loepp another and Schloffer has shown by the X ray a case that primarily showed only a fractured acetabulum but 5 days later when again subjected to X ray examination there

was found to be a dislocation due to contraction of muscles. In simple cases the prognosis is good if reduction and immobilization are accomplished early. In complicated cases the outlook is grave. There is generally some limitation of motion with slight shortening and stiffness of joints depending upon the severity of the fracture and associated injury. Vaughan's 18 cases showed 3 perfect results 7 with limited motion 7 with shortening with stiff joints 1 with outward rotation and abduction and 1 totally incapacitated.

**Mortality.** None of the 15 cases in this series died. Fuller reports 50 per cent mortality and Vaughan found 50 per cent mortality in 6 collected cases and 47 per cent in 37 doubtful cases. The mortality is due to visceral injuries complications and shock. Of 11 cases reported by Katz 6 died in the first week. Arreger reporting 33 collected cases of fractures of the pelvis (diagnosis of central fracture dislocation proved in only 6 cases) showed a mortality of 16 cases mostly in the first week.

In general it may be stated that simple acetabular fractures with central dislocation give a low mortality. Cases complicated by other pelvic fractures causing intrapelvic and intra abdominal injuries and by cranial injuries are to be regarded as grave their outcome depending upon early recognition and appropriate treatment.

### SUMMARY OF FIFTEEN CASES AND REVIEW OF THE LITERATURE

1. Penetrating fracture of the acetabulum with central dislocation of the head of the femur is a distinct entity and not a rarity. It is apparently on the increase because of the onward march of civilization.

There are varying degrees of this fracture dislocation.

3. Associated pelvic fractures occur in over 50 per cent of cases.

4. Pelvic and abdominal complications are ever to be borne in mind anticipated and treated early.

5. Nerve injuries occur as high as 33 per cent. Careful examinations and due regard to patients complaints are to be emphasized.

TABLE II—SUMMARY OF FIFTEEN CASES

[illegible]

6 Unrecognized fracture dislocations occur too often

7 Reduction is generally best achieved by anesthesia, flexion and wide abduction with slight external rotation

8 Recurrence takes place if immobilization is not properly secured

9 Immobilization when possible should be secured by a plaster spica to the body hip and lower extremity placed in abduction slight flexion and external rotation

10 Mortality ranges from 0 to 50 per cent depending upon associated injuries complications and treatment

11 Careful and frequent examinations early treatment of all injuries and observant study will effect a shorter convalescence better anatomical result and increased function

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## TRANSVERSE CONIOTOMY FOR THE RELIEF OF CERTAIN TYPES OF CASES OF LARYNGEAL OBSTRUCTION

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**I**N a certain number of cases laryngeal obstruction ends fatally either because immediate surgical attention is not available or because of untoward results following tracheotomy. Transverse coniotomy (incision of the cricothyroid ligament) offers an effective procedure in some of these instances. Its simplicity puts it within the hands of every practitioner in time of emergency.

### HISTORY

The origin of relieving respiratory obstruction by the operative establishment of an artificial opening below the point of obstruction can be traced back to ancient medicine. A representative of the renaissance was the anatomist Fabricius ab Aquapendente (1550) first devised the operation of low tracheotomy, which remained the only classical method until 1766. At that time another celebrated anatomist, Vicq d'Azyr (14), proposed before the Société Royale de Médecine a new operation based upon the division of the cricothyroid ligament (ligamentum conicum) and the insertion of a cannula for the relief of respiratory obstruction. Soon after this work was published a controversy arose as to the practicability of Vicq d'Azyr's operation. Among those who strongly recommended its use were Furrer, Bichat and Desault (7). A number of urgents successfully performed the new laryngotomy on human beings but the operation was never generally accepted and soon disappeared.

Early in the nineteenth century Boyer originated the high tracheotomy. About the same time Desault (8) passed a curved tube along the nostril into the opening of the glottis and thus established the basis for Osler's work on the intubation of the larynx. In 1910 Otto Franck (5) urged the transverse division of the trachea. More recently Bingel (1) has ardently advocated this method and has pointed out its advantages. The operation however is a very

old one as it was introduced by Antyllus in the second century.

A vast amount of literature has accumulated on the surgery of the larynx and trachea. However only one author (12) as far as we know mentions that the incision of the cricothyroid ligament alone suffices to produce a satisfactory opening and does not need to be followed by the introduction of a tracheal cannula.

### ANATOMY

The outstanding anatomical landmarks in this operation are the thyroid and the cricoid cartilages which are easily outlined on superficial palpation. Between the lower border of the thyroid and the upper border of the cricoid cartilage there extends the cricothyroid ligament. The anterior portion of this structure has a trigonal shape its sides being formed by the cricothyroid muscles (Fig. 4).

The sternothyroid muscles diverge upward and do not lie in front of the conic ligament. The sternohyoid muscles lie laterally to the ligament however the latter is covered by a fringe of fascia connecting the muscles. Anterior to the ligament embedded in a small amount of connective tissue there are a few venules and lymphatic vessels penetrating the membrane. A small lymph node may also be found here. The so called prelaryngeal lymph gland. Also a small anastomotic arterial branch crosses this field transversely connecting the superior thyroid arteries which run laterally at a distance from the conic ligament. The course of this small artery is parallel and close to the lower border of the thyroid cartilage. This vessel can hardly be of any serious practical importance and is not liable to be cut in a transverse incision of the conic ligament near the upper border of the cricoid cartilage.

In a certain number of individuals the lobus pyramidalis of the thyroid gland reaches the intercricothyroid space extending from the thyroid isthmus upward. It rarely consists

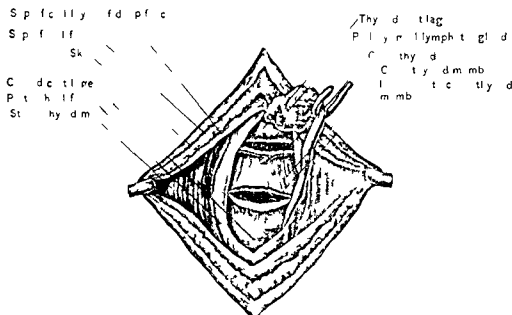


Fig 1 Relations anteriorly of the cricothyroid membrane (From Deaver's *Surgical Anatomy*)

of glandular elements but is essentially a small rudimentary structure made up of connective tissue and is of no significance whatever (12). The next layers anteriorly are the superficial fascia and lastly a more or less insignificant amount of subcutaneous tissue and skin. In some individuals the median vein of the neck may run subcutaneously in front of the conic ligament. Figure 1 is an illustration of the topographic anatomy of the operative field according to Deaver.

Posteriorly toward the laryngotracheal lumen the conic ligament is covered by a thin layer of connective tissue lying directly between the ligament and the mucous membrane of the larynx. This layer connects the ligament with the mucous membrane very firmly so that both adhere closely to each other. The entire thickness of these structures from the surface of the skin to that of the mucosa in many individuals does not exceed 8 millimeters.

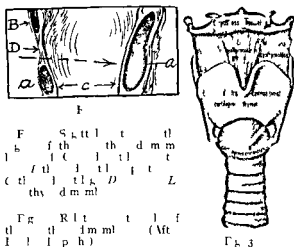
With regard to the topographic relation of the conic ligament to other nearby structures of the larynx the following has been ascertained by the examination of adult specimens.

A transverse incision of the conic ligament above the cricoid cartilage opens the upper respiratory tract at least 12 millimeters below the level of the true vocal cords. The lumen of the respiratory passage at the level of the

conic ligament is fairly round and has a diameter of about 15 millimeters. It is maintained and supported by the cricoid cartilage which is a strong complete ring and increases considerably in size from before backward. Indeed the posterior wall of the cricoid cartilage is about 2 centimeters high and about 3 millimeters thick. This is the only firm cartilaginous wall between the laryngeal tracheal tube and the esophagus (Fig. 2).

As to the dimensions of the conic ligament itself its height is about 10 millimeters its length about 15 millimeters. It does not however end sharply but finds its continuation in the conus elasticus a structure extending along the walls of the lower division of the larynx (Fig. 3).

Histologically the conic ligament is a fairly firm elastic membrane whose fibers run parallel to the axis of the body from the cricoid upward to the thyroid cartilage. Consequently a transverse incision perpendicular to the traction force of the fibers of the membrane divides the latter into two parts which retract spontaneously. The resultant opening has a fairly regular oval shape with a long transverse and a short vertical axis and it remains open of its own accord. The divided mucosa closely adhering to the ligament through dense connective tissue follows precisely the spontaneously retracting parts of



the ligament. The phenomena were produced on fresh cadavers at autopsy.

#### EXPERIMENTS ON DOGS

The anatomical difference between transverse coniotomy in human being and in dog are slight. The distance from the vocal cord to the conic ligament in dogs is less than in the human subject. The sternohyoid muscles in dogs lie directly in front of the conic ligament whereas in man the muscle leaves the ligament free between them.

Each animal was anesthetized by the administration of ether and fixed on the operating table with the head in extension. Then the administration of the anesthetic was stopped and the dog's head including the mouth and nostril was tightly bandaged with cotton towel and adhesive plaster. Thus breathing through mouth or nostril was rendered impossible. A longitudinal incision was made in the midline from the incision thyroid down to the lower margin of the cricoid cartilage. The superficial fascia was split and retracted laterally to expose the sternohyoid muscle which were pulled aside as shown in Figure 4. The conic ligament was incised transversely and the incision was followed by immediate spontaneous retraction of the divided part including the mucous membrane. In every instance the dogs at once started breathing through the artificial opening. It was possible in all cases to perform the operation rapidly enough to relieve the animal from asphyxia. No complications arose on the

operating table and ligatures were not necessary. The operative procedure was carried out with only one instrument—a scalpel and was performed without assistance.

Before the dog was removed to the case precautions were taken in order to maintain the coniotomy opening patent as the material obstructing the mouth and nostril were left in place and respiration could be carried on only through the artificial opening. Strip of adhesive plaster were fixed to the skin on either side of the incision wound and were united in back of the dog's neck. The sternohyoid muscles which in dogs lie directly in front of the cricothyroid membrane being sutured to the overlying skin were retracted with it. In front of the operative field a small thin layer of gauze was applied by means of collodion. As suture material silk was used.

A lapse of 4 hours was allowed between the operation and the removal of the material obstructing the dog's mouth and nostril. During that time the respiration remained undisturbed and the heart action was equally good. Following the removal of the obstructive material in one group of dogs the artificial opening was kept patent for a period of 4 days. Then the skin edge were permitted to approximate and the wound was allowed to close. In another group of dogs the closure of the wound was facilitated immediately after the removal of the obstructive material from the mouth and nostril. In some cases the edge of the skin as well as those of the divided fascia were united by a few interrupted suture. In no case however was the wound closed completely.

Two dogs were killed and autopsy were carried out 4 hour after operation. When the interior of the laryngo-tracheal passage of the animal was exposed no blood was found in the lumen and the mucous membrane was pink and normal in appearance. The vocal cord showed no trace of any injury. The entire mucosa showed no change except at the cricothyroid interstice. Here in approximately oval shaped opening was seen with clean cut and sharply outlined edge. The mucous membrane adhered closely to the divided parts of the conic ligament (Fig. 5).

In the dogs allowed to live the wounds became infected. However the infection remained localized and aside from the delayed healing of the wound was of no appreciable significance. Soon after the closure of their wounds (8 to 15 days after operation) the dogs started barking again and there was nothing suggestive of any laryngeal lesion. These dogs were allowed to live for a period of from 1 to 5 months and were further observed with regard to the possibility of undesirable after effects. In no instance was there any evidence of vocal disturbance or of any impairment of breathing.

At autopsy the following was found uniformly. The skin was movable over the operative field and the site of the longitudinal skin incision could be found only on very close examination. The larynx and trachea were removed from the body *en masse*. Externally these organs showed no deformity. The lumen of the larynx at the cricoid level was fairly round the entire mucosa was smooth and pink in color and there was no loss of continuity in the lining of the mucous membrane. The cricothyroid inter space showed no appreciable changes on superficial inspection. The transverse incision through the conic ligament was not perceptible. Only on very careful examination could one make out in the submucous layer a round area about  $\frac{3}{4}$  centimeter in diameter suggesting a radiating scar tissue formation with its center approximately in the middle of the cricothyroid inter space. The vocal cords were found intact and covered by a lining of normal looking mucous membrane.

# REPORT OF CASE

IS A white male 60 years of age complained of increasing hoarseness for 2 months. The patient had a loud inspiratory stridor and his speech was only a hoarse whisper. Laryngoscopic examination revealed a hard immovable mass involving both the true and false cord on the left extending upward posteriorly and along the left wall of the larynx. This mass protruded above the left aryepiglottic fold and obstructed a very considerable part of the entrance to the larynx but was not ulcerated. The right vocal cord was movable the left was fixed. The epiglottis was swollen and congested. There was nothing else of significance in the physical examination. The history was irrelevant except for the fact that the complaint dated back some 4 years prior to admission to the hospital.

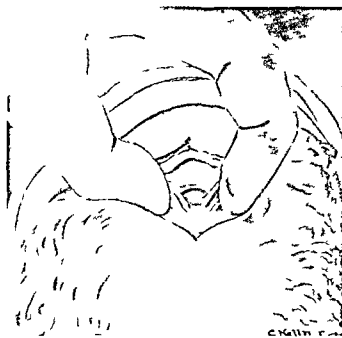


FIG. 1. Transverse conic ligament (lo)

The condition obviously was a carcinoma of the larynx. It was suggested by Dr H. I. Syam who knew of our work and to whom I am indebted for the privilege of reporting this case that a transverse conic ligament incision on the patient instead of a preliminary tracheotomy.

The conic ligament was performed under local anesthesia with the patient's head in extension. The longitudinal incision of the skin was about 3 centimeter long and the transverse incision of the conic ligament about 1 centimeter long. The patient remained well during the operation and started breathing through the conic ligament opening immediately after the conic ligament was split. All bleeding points were carefully ligated. The skin edges were caught by two stitches (ilk) and the thread were tied to strips of gauze on either side of the wound. The two strips were tied on the side of the neck so as to retract the wound edges somewhat from the opening. On inspection of the respiratory passage through the conic ligament opening the mucosa was found to be of normal color it was possible without any difficulty to inspect the lower surface of the vocal cord.

Soon after the operation it was observed that the patient was not breathing through the conic ligament opening satisfactorily as he had on the operating table. On inspection of the wound a small flap of loose prelarvicular tissue was seen attached near the conic ligament opening. This piece of loose tissue during inspiration was blown in toward the tracheal lumen obstructing the opening in the conic ligament in a valve like manner. Along the edges of the skin were not retracted from the conic ligament opening far enough to avoid its being covered by the skin when the patient moved his head to the side.

For this reason about 1 hour after the opera-





Fig. 1. Tracheotomy (d.)

tion as performed a tracheal cannula was introduced through the coniotomy opening and a kept in the respirator lumen for a period of 5 days. On the 13th day the cannula was removed. The larynx united the patient to the conic ligament as depending closely to the underlying tissue and the opening remained in the regular position in which the patient chose to hold his head. For the following 14 days the patient remained perfectly comfortable without any cannula. As the treatment of a respiratory tract through the opening ten days after the operation the respiratory passages in the lumen of the opening it was frequently necessary to remove from it the dried up particles as well as the musty expectorated material. Figure 6 represents the patient after the tracheotomy operation. The patient remained in the hospital after the preliminary coniotomy performed by Dr. Samuel C. Harvey. During the operation the anesthetic was administered through a tracheal tube introduced into the trachea through the coniotomy opening.

#### PROCEDURE IN MAN

In operating on man the skin edge should be retracted on either side and fastened to the underlying tissues by mattress sutures entering the skin about centimeters away from the edge and passing through the anterior cricoid muscle of that side thus preventing obstruction of the coniotomy opening regardless of the position of the head and neck. Strips of adhesive plaster may replace this procedure if necessary. After a few days the sutures may be removed and the adhesions allowed to maintain in the desired position of the skin. Whatever is done after the coniotomy opening is no longer needed the wound should not be closed tightly and the conic ligament should not be sutured.

It is necessary to identify the cricothyroid interpace before the incision is made. The



Fig. 2. Tracheotomy (d.)

skin incision should extend from the incision of the thyroid to the lower border of the cricoid cartilage. The conic ligament should be incised exactly transversely. The loose pre-laryngeal tissue must be removed as we found from experience in the reported case.

#### ADVANTAGES AND DISADVANTAGES

A simple solution for the emergencies of laryngeal obstruction by the present methods is not always possible. While O'Dwyer's intubation method is of great value chiefly in diphtheria in children it is not advantageous in other conditions. Both intubation and tracheotomy require special instruments and tracheotomy is a major operation which demands skill and some experience on the part of the operator. Even when performed under the best circumstances tracheotomy may give rise to serious complications such as hemorrhage. Following the teachings of Chevalier Jackson (8) most tracheotomies in this country are of the low type so that the serious complication of laryngeal stenosis is eliminated. Under certain circumstances however stenotic changes may follow tracheotomy regardless of the anatomical level at which the operation was performed.

In contrast with the methods the operative field in transverse coniotomy is most superficial and the anatomical structure in

involved are of relatively little significance cartilaginous substance is not cut and the lumen of the air passage is not altered the method reduces the possibility of hemorrhage and other complications to a minimum it opens up the largest of the interspaces between the laryngotracheal segments below the vocal cords it offers to every practitioner a simple and easy means of interference in emergency and it requires the use of only one instrument—a knife The postoperative development of other things being equal is most favorable

It is interesting to note in connection with this operation that the chief arguments advanced against it for the past 150 years have always remained the same the proximity of the operative field to the vocal cords and the wearing of a cannula in the subglottic space Harmer (6) arguing in favor of this operation claims that a tube introduced through the cricothyroid membrane lies in the subglottic space well below the vocal cords and that healing of the wound takes place in from 3 to 6 days St Clair Thomson states (10)

Intercricothyrectomy is free from danger and easy to perform and the wound will heal in a few hours Both Harmer and St Clair Thomson find the method advantageous not only in sudden laryngeal obstruction but as a preliminary temporary measure in certain other operations

Since we feel justified in stating that on anatomical grounds as well as on the basis of our results on living subjects coniotomy does not require the use of a cannula at all it is needless for us to share the fear of a cannula in the subglottic space As to the possibility of directly injuring the vocal cords it may be said that such an injury cannot occur if the operation is performed with any care at all It is necessary to realize that indications for transverse coniotomy are limited It is obvious that only such respiratory obstructions come into consideration as are located above the level of the cricoid cartilage

The so called oedema of the glottis is the outstanding condition in which transverse coniotomy may save the patient's life It may occur at any age and may be associated with many conditions such as Ludwig's angina or any other inflammatory process in the vicinity

of the larynx burns or caustic irritation to the fauces foreign bodies in or injury to the larynx infectious oedema some acute and chronic infections general anasarca Because of its frequent abrupt onset its rapidly progressive character and its tendency to give rise to no distressing symptoms at the onset these conditions often confront the practitioner when the patient is in real danger of suffocation In connection with oedema of the glottis it may be pointed out that this is a minor condition the condition manifests itself by a gross infiltration chiefly of the aryepiglottoid folds and not of the glottis It is an anatomically as well as clinically (11) well established fact that oedema of the larynx does not spread downward and never involves the subglottic space The site of this lesion is always at a higher level than the operative field of transverse coniotomy

Foreign bodies may lodge in the additus ad laryngem and produce a rather alarming situation For some reason or other it may be impossible at the time to remove the foreign body from the larynx and the physician may be urged to establish rapidly an artificial respiratory opening

Injuries to the larynx particularly cuts through the hyothyroid membrane and fractures of one or more of the cartilages may become very serious The resulting inflammatory reaction may cause severe oedema of the larynx or the lumen of the larynx may be occluded by either a dislocated fragment or a hematoma developing in the submucous connective tissue For this reason such patients are in constant danger For the sake of safety some authors emphasize the necessity of a prophylactic tracheotomy in cases of trauma of the larynx Provided the cricoid cartilage has not been fractured transverse coniotomy should be preferred invariably in such cases

For the establishment of a preliminary artificial respiratory opening transverse coniotomy approaches an ideal of safety If it is desired to administer a general anæsthetic this can be accomplished either through a soft rubber catheter inserted through the coniotomy opening or else by saturating with the anæsthetic a loose piece of gauze placed in front of the opening As an example of an indication of coniotomy as

a preliminary measure the operation for the removal of a carcinoma at the base of the tongue may be mentioned. Furthermore the possibility of inserting a radium needle through the cricothyroid opening for direct application for subglottic tumor may be mentioned here.

CONTRA INDICATIONS

In *diphtheria* cricothyroidotomy should not be practiced because the obstruction of the air passage by the membrane may extend below the cricoid level. In *children* the distance between the cricoid and thyroid cartilage is too small and promise little success. We therefore believe that cricothyroidotomy should not be practiced in children.

SUMMARY

- 1. Many instances of laryngeal obstruction in the adult can be relieved by the transverse cricothyroidotomy of Vieillard Azar.
- 2. The introduction of a cannula is not a necessary step in the procedure because of the anatomical character of the cricothyroid membrane.
- 3. The procedure is simple and should be used in such emergencies as must be met without the assistance of a surgeon.
- 4. It is not applicable in children because

of the small size of the membrane and not in obstruction which may lie below the thyroid cartilage as in diphtheria.

5. The operation is of particular value in the establishment of a temporary artificial airway in operations at the base of the tongue about the pharynx and buccal cavity.

6. This paper is based upon anatomical studies on the cadaver, experimental work on the dog and upon the application of the procedure in one case.

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# MENSTRUAL FISTULAE OF POSTOPLASTIC AND ENDOMETRIAL ORIGIN

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**M**ENSTRUAL FISTULA is proposed as a term for fistulae in laparotomy scars characterized by periodic discharge of blood more or less coincident with normal menstruation. Two kinds of such fistulae have to be considered: (1) those due to direct communication with the uterine or tubal mucosa; (2) those due to postoperative enclosures of endometrial tissue in abdominal scars.

## ETIOLOGY

Most menstrual fistulae are of postoperative origin, though a few such fistulae have been formed by a pus tube or a tubal pregnancy spontaneously breaking through the abdominal wall (cases of Bouzoul 4, Devere 8, Schlink 55). Postoperative menstrual fistulae are caused:

1. By postoperative direct communication with uterine or tubal cavity: (a) following cesarean section; (b) after operations for pelvic inflammatory disease, salpingectomy, partial hysterectomy; (c) after ventrofixation of the uterus.

2. By postoperative enclosure of endometrial (adenomyomatous) tissue in the abdominal wall in the course of hysterectomy, ovariectomy, ventrofixation, etc. such enclosed tissue also at times causes a periodic menstrual discharge, as we will show later on.

It is obvious that the menstrual discharge from a fistula going into the uterus is much greater than that from the type caused by endometrial enclosures; in fact under certain mechanical conditions the whole or most of the menstrual flow may emanate through the fistula in the former type. The enclosures give only a slight but more or less periodic discharge.

Of fistulae following cesarean section the following notes were found in the literature:

Olshausen (1) mentioned in his lectures that the so-called Porro operation was at times followed by menstruating fistulae. The

old Porro operation meant supracervical hysterectomy immediately after a cesarean section with suturing of the cervical stump into the lower angle of the abdominal section. The aim of the procedure was prevention of peritonitis emanating from the uterus or after its removal from the infected cervical stump. As tubes and ovaries were usually not removed in the Porro operation, the broad cervical stump menstruated the natural way through the vagina. If the cervical stump was attached to the abdominal wall in abdominal wall, it often resulted in communicating with the cervical canal and therefore participated in menstruation.

Holland (15) mentions the possibility and gives the origin of such fistulae after cesarean section. Discussing defects in the classic cesarean operation, he says: "Every one knows how during the stage of closure of the wound the incision tends to gape transversely and the edges are drawn apart when the uterus contracts. If the contractions are very powerful small gaps which become occupied by blood clot inevitably occur between the sutures. Many cases have been described in which it has been necessary to reopen the abdomen or which have come early into the postmortem room and the wound has been found widely open. If infection of the uterine wound occurs, healing is delayed and an imperfect scar is formed. The liability of such thin scars to rupture in subsequent pregnancy or labor is very great. Even in case of mild infection the position of the incision makes adhesions between the uterine scar and omentum, intestines or abdominal wall almost inevitable. Such adhesions if intestines are involved often lead to chronic or acute intestinal obstruction in the adherent intestine or breakdown of the kinked intestine with formation of fecal abscess and fecal fistula. Then perforation of the thinned adherent uterine scar by erosion from the fecal fistula may lead to menstrual fistula. We will see later that





Fig 5 Case 3 Mrs M Postoperative menstrual fistula Direct communication of the fistula through the endometrial enclosure into the uterine cavity Also note the intestinal adhesions to the enclosure

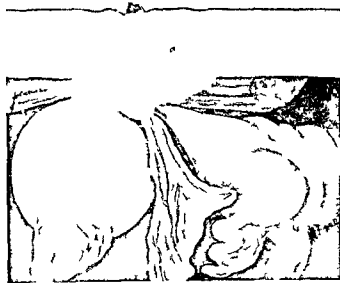


Fig 6 (a) Mrs M Menstruating postoperative fistula with abdominal closure Note the cystic areas penetrating the wall and attached to the cystic right ovary Also note the intestinal and omental adhesions

left sided tubo ovarian abscess was opened which contained about 50 cubic centimeters of pus without odor The left tubo ovarian sac was freed and resected The intestinal loop was so much damaged and so fistulous in several places that resection was performed This patient died from peritonitis 15 days after operation

There are over 40 cases of this type reported in the literature so far for which the use of the term menstrual fistula is justified because of the direct communication of the uterine cavity with the abdominal fistula Their origin from the perforation into the uterine cavity after caesarean section and from deep sutures into the uterus introduced for ventrofixation is easily understood As the tubal mucosa either takes part in menstruation or communicates with the endometrium it is also obvious that tubal fistulae from salpingectomies or from spontaneous rupture of tubal abscesses and tubal pregnancies through the abdominal wall may also emit menstrual blood

Our next cases of menstrual fistulae are of a different and very interesting type due to postoperative enclosures of endometrial tissue in the laparotomy scars In 1896 von Recklinghausen (41) perhaps gave the first lucid

description of this type of tumor starting from the uterine glandular and muscular tissue under the heading of adenomyoma and cystadenoma He considered that these tumors started from enclosures of remnants of the wolffian ducts The next important publication is by Cullen (17) who considered the origin of this type of tumors as endometrial cells invading the muscular layers from an adenomyoma of the uterus A third theory of their origin is mainly defended in recent years by Sampson (30, 31, 32) in his many publications He claims that this type of tumor originates from endometrial cells escaping through the tube during menstruation and implanting themselves usually in the ovary but also in the peritoneum and the intestinal serosa The latter theory has perhaps found the most followers but cannot explain the origin of all these tumors Therefore several authors maintain that these tumors have different causes that some are caused by transplantation and enclosure of endometrial cells or the tumor starts from an embryological enclosure (Davis and Cron 6 and others)

Because of the different views as to etiology these tumors which really belong in one



of endometrial tumors in laparotomy scars Nicholson compiled in 1926 15 followed ventrofixation 6 operations on the tubes and ovaries 1 or 2 each for ruptured uterus hysterectomy and round ligament operation showing the frequency of these enclosures after ventrofixation

As to the dispute briefly referred to about the origin of these tumors Simpson's theory is that the endometriosis is due to the escape of menstrual blood through the tubes into the peritoneum and the consequent local reaction produced by endometrial cells carried along with the menstrual blood. In favor of this theory are the following observations

Jacobson (14) and Dossena (9) produced endometrial implants experimentally in the peritoneum of animals by scattering endometrial cells into the abdominal cavity. The question as to whether menstrual blood issues from the tube during menstruation has been disputed but Curtis operated purposely during menstruation and saw in 3 cases menstrual blood coming from the tube. Danforth saw the same on at least 1 occasion. Curtis asserts that 16 cases of endometrial implants all had retrodisplacements of the uterus favoring the back flow of menstrual blood and all had patent tubes. Chocolate cysts occur only in patients with patent tubes (Danforth offers this in favor of the implantation theory) also the most pronounced complaint of such patients is *painful* menstrual periods. Schwartz mentions the fact that the ovary is the favorite organ for implantation of endometrial transplants because it is the nearest organ to the tubal orifice. Davis and Cron (6) observed that in one case the implantation of endometrial cells followed transuterine inflation.

On the other hand Novak operated on 13 women during menstruation without seeing any menstrual blood coming from the tubes. He found endometrial cells only in 7 tubes of the several hundred examined and these cells had not the characteristics of menstrual endometrial cells. Nicholson does not accept the theory of endometrial transplantations or the origin of embryonic enclosures of this type of tumors. He believes that they are caused by proliferation of the peritoneal epithelium in response to some irritation.

Most likely there are several origins of such tumors. It is reasonable to claim implantation of endometrial cells in the many cases now reported in which endometrial enclosures occur along the tract of ventrofixating sutures in the abdominal wall or where a cystic ovary connect directly with an endometrial tumor in the scar. Endometrial enclosures in the vaginaectopic seem to be more of an embryonic enclosure type starting from Wolff's or Muller's ducts. The outcome of the dispute will probably be that tumors in different locations have different origins. Mouat (24) gives 5 varieties of endometriosis

1 Primary endometriosis direct invasion of myometrium by endometrial cells adenomyoma of uterus and tubes

2 Peritoneal or implantation endometriosis endometrial cells invade the peritoneal surfaces

3 Transplantation endometriosis in abdominal scars

4 Metastatic endometriosis extraperitoneal along the round ligament and in hernia sacs (comparable to metastasis from carcinoma)

5 Developmental misplaced endometrial tissue

The menstrual discharge from endometrial enclosures in scars of the abdominal wall is not so readily explained as the menstruation from direct fistula. At times (Fig 5) the endometrial enclosure still communicates with the uterine cavity at the place of ventrofixation or with a cystic ovary (Fig 6). Here again the menstrual discharge through the fistula is understood. In our third case of this type and most other cases in the literature such connection between fistula wall enclosure and uterine cavity or ovary was not found. Hence we must come to the conclusion that endometrial enclosures in a laparotomy scar and elsewhere are apt to secrete and discharge blood at intervals. This indeed is true and borne out by actual records of cases and the anatomy of the enclosures.

Menstruation or menstrual symptoms from these tumors are mentioned frequently in the literature. Some of Cullen's cases gave a history of enlargement of the umbilical adenomyoma at the time of menstruation and one of his patients noticed a serous discharge dur-



ing catamenia. Mahle and MacCarty describe an adenoma of the umbilicus a hard bluish tumor that broke open and discharged bloody serous fluid. This tumor became quite painful at the time of menstruation. Nicholson mentions that menstruation was often marked by increase in the size of the tumor and pain and in 3 cases was accompanied by a bloody discharge from the surface of the tumor. Mahle and Carpenter give cases of abdominal scar enclo ure and state that the lump was painful at the time of menstruation also the two inguinal cases had the same complaint and o did the one with the adenomyoma in the rectovaginal septum. One of them had a polypoid tumor formation raising the vaginal mucosa. The occasional relation to menstruation of pain and swelling of the tumor or less frequently a bloody discharge should be very suggestive of adenomyoma. Nicholson call the e tumor accessory uterine build as well as function. Heaney (11) states that usually the no lules swell and are painful during the menstrual period and afterward for several days. Lochrane (19) under the heading of Endometrial Adenomas describes a postoperative cyst in the abdominal wall that discharged blood. Sampson (31 33 30) also states that endometrial implants react to menstruation pregnancy and menopause and doe the mucosa lining the uterine cavity. F L Keene s case of endometrial invasion of the bladder healed after bilateral ovariectomy. In criticizing the report Polak add that endometrial tumor atrophy when ovarian stimulus ceases. Even in endometrioma of the sigmoid caused dysmenorrhea (Sharple 38). Heaney (11) mentions in reference to the endometrial tumors in the rectovaginal septum that of this type of tumor became fistulous in the vaginal vault producing polypoid like formation. One of ours did this also.

From our own observation and from the data in the literature it is evident that pain as well as bloody discharge are outstanding symptoms of endometrial tumors.

Our 5 case of endometriosis 3 in abdominal scar in the rectovaginal septum had menstrual or near menstrual symptoms from their endometrial tumors. These cases follow

CASE 3 Mrs G M 27 years old admitted to Harpe Hospital February 1 1924. Complaint prior to discharge of blood from a fistula in the abdominal scar. She had been operated upon 6 years previous removal of left tube and ovary through a median laparotomy. A fistula followed this operation and discharged some blood at the time and became more painful with increased discharge at the time of the menstrual period. Several times the fistula had to be reopened to evacuate painful menstrual retention. The diagnosis was a menstrual fistula.

An elliptical incision surrounding the fistula and scar was made. In the wall was found a typical endometrial enclosure with bloody spaces. The fistula tract led to the adherent fundus uteri. Several intestinal adhesions were present and adherent to the fistulous tract. The fistulous tract was excised from the uterus. The small round of the uterus was sutured. The abdomen was closed tight with special attention to the fascia to avoid further formation of hernia.

CASE 4 Mrs A S age 35 as first seen on July 9. She had had one miscarriage at the age of 4 and 4 children. She was operated on when 31 years old at a Toledo hospital. Uterine tumor, right tube and ovary were removed. The wound drained. In the scar of this operation a tumor developed and grew in size. The tumor was tender, very painful during menstruation. She identified it as though it ulcerated. At such times the black bloody discharge stained her underwear. The tumor profuse menstruation occurred every 3 weeks.

The other 2 healthy appearing women had a median laparotomy scar. In the lower angle of the scar a raised dark red firm erythematous cystic place 5 centimeters in diameter adherent to skin and fascia and muscle. In its center a small cystic area moist on its surface from some bloody discharge.

Vaginal examination showed the uterus large adherent to the cervix in the ego of the tumor. A diagnosis of blood wall enclosure with a menstrual fistula was made.

At operation on October 18 1926 an elliptical excision of old laparotomy scar including a carcinoma like tumor 1 inch in diameter was made. The tumor followed the hole and on cutting the abdominal string going to the fundus of the uterus. Very difficult dissection was covered up the hole pelvis. After they were separated a fistula developed fibrous uterus developed. The fibrous uterus posteriorly to the cervix. The right adnexa had been removed a previous operation. The left hysterectomy was performed. The removal of the left adnexa a small ovarian stump being left. Freely cut out of all abdominal adhesions were cleared out. The pathological finding of the uterus removed was adenomyoma of the abdominal wall. The patient was cured.

CASE 5 Miss V. I. 22 years old was seen in May 1917. A left oophorectomy had been performed 6 years previously for a pelvic inflammatory condition. In the lower angle of the laparotomy scar there was a hard irregular enclosure that had required lancing during the past year or broke to discharge some blood. The tumor was always painful during menstruation and the pain was relieved by opening one of the blood cysts that formed. This patient was operated upon for menstrual fistula on May 25 1927 (Figs. 6 and 7).

The whole endometrial mass was dissected loose. It penetrated diffusely into the right rectus muscle and communicated with an adherent cystic right ovary. The appendix also was involved in the adhesions. Excision of the whole mass and resection of the cystic ovaries led to a complete cure.

A history of our 2 cases of rectovaginal enclosures follow.

CASE 6 A Miss H. M. a nurse who complained of pressure on the rectum and pain which was so much worse during menstrual periods that she had to take anodynes. A small tumor formation in the posterior vaginal vault could be felt. On laparotomy a fibromatous tumor was found in the rectovaginal septum containing bluish cysts. It looked like a rudimentary duplication of the uterus. The tumor was then also exposed through the vagina and some chocolate fluid was removed from a hemorrhagic cyst. Complete excision of the mass was not done on account of the intimate relation to the rectal wall. Following this operation dark fluid was discharged from these vaginal cysts and these became very painful during menstruation. The pain was relieved sometimes by puncturing the small cysts in the vaginal septum.

CASE 7 Mrs. C. G. 35 years old was referred for a tumor similar to that in Case 6 palpable in the rectovaginal septum and very painful during menstruation. We thought we had to deal with a tubo-ovarian cyst but at operation we found the same type of nodular mass with cystic enclosures—an endometriosis of the rectovaginal septum.

The literature and our cases mentioned show that tumors occurring in laparotomy scars may be identical with endometrial tumors which are found elsewhere on the surface of the peritoneum in the rectovaginal septum, sigmoid, etc. These tumors have arisen from 2 to 5 years after laparotomies (Nicholson). They always seem to be restricted to the lower half of the abdominal wall. It has been established that these tumors of the wall are identical in structure and cyclic function with those of the uterine mucosa (Lemon and Mable). Moreover it is very probable that in

some cases there has been direct transplantation of uterine endothelial cells by means of the needle and suture in ventrofixation. It is also important that menstrual fistulæ are frequently complicated by fecal fistulæ. Fistulæ after cesarean section usually followed unsatisfactory suture of the uterus.

Fecal fistulæ were present in addition to the men-trail in Puccioni's second case and in Bouzoi's case. In Deverre's case a gangrenous appendix was involved in the adhesions around the fistulæ. Of our patients Case 1 and Case 4 had intestinal fistulæ with the menstruating fistula. Intestinal adhesions without fistulæ are mentioned in Puccioni's first case and were present in Cases 3, 4, and 5 of our series. All of ours had postoperative hernias in the scars around the fistula just as mentioned in Puccioni's first case.

All the facts show that a certain prophylaxis against menstrual fistulæ is possible and coincides usually with modern surgical rules for pelvic operations. Cesarean section should be done in the low subperitoneal part of the uterus, the peritoneal (bladder) flap covering the uterine suture and low location of this scar will prevent its adhesion to the wound in the abdominal wall. Such adhesion is favorable to the formation of a uterine fistula. If a high cesarean section cannot be avoided proper suturing of the uterus will prevent to some extent the formation of such fistulæ. In dealing with tubal and uterine stumps good peritonealization and oversuturing of raw surfaces will prevent adhesions between wall and uterus or tubes.

Ventrofixation in the presence of pelvic peritonitis seems to be especially prone to be followed by menstrual fistula. If the fixating suture penetrates into the uterine cavity and fixates the fundus to the laparotomy, an excellent chance for menstrual fistula is created. Intestinal adhesions to ventrofixations with linking breaking down of the linked loop and formation of a fecal fistula will create septic conditions around the ventrofixating sutures again easily leading to uterine perforation and fistula. Ventrofixation by deep sutures through the fundus in inflammatory conditions is best avoided and in any case generally has not much in its favor.

Wall enclosures are created when raw uterine tubal and ovarian surfaces come in contact with the abdominal wound. The covering of such raw surfaces, uterine stumps, etc., will prevent formation of abdominal wall enclosures and thereby the production of menstrual fistula. Real implantation of detached uterine or ovarian tissue in the scar is rare and is obviously avoidable.

In operating for these fistulae the presence of a fecal fistula or the injury to densely adherent intestines renders the prognosis of such operations somewhat more serious than one would think. Death in Case 1 was from peritonitis following the operation, no doubt due to infection from the fecal fistula. At a certain clinic in view of several unsuccessful attempts to close the fistula further operations were declined, no doubt wisely, as the outcome of our operation indicates. However the discomfort of this patient from the still complicating tubal abscess demanded interference. Because of difficult adhesions or the presence of a fecal fistula the operation is serious. Then too if the adhesions prevent exposure and resection of the fistulous uterus or tube the fistula is likely to recur (Case 1).

Radical operation for a fistula should mean total excision of the fistulous tract or endometrial scar enclosure in continuity with the uterine fistula or ovarian cysts by hysterectomy total or partial or ovariectomy as the case may be.

#### CONCLUSIONS

1. Menstrual fistulae are fistulae in the abdominal wall characterized by a periodic discharge of menstrual blood.

They rarely originate from spontaneous rupture of a pus tube or an extra uterine pregnancy through the abdominal wall usually they follow operations, caesarean sections, ventroservations and salpingo ovariectomies and then either connect directly with the lumen of a tube or the uterine cavity or connect with menstruating endometrial enclosures in the laparotomy scar.

3. Frequent complications with extensive intestinal adhesions and fecal fistulae occur and render the operation for them somewhat difficult.

4. The name menstrual fistula and perhaps also menstrual tumor for postoperative and endometrial enclosures is proposed to emphasize their outstanding symptoms just as fecal and urinary fistulae describe an entity.

5. Menstrual fistulae and the endometrial tumors are painful and discharge more or less blood at the time of menstruation.

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# CLINICAL SURGERY

FROM THE DIVISION OF SURGERY, MAYO CLINIC

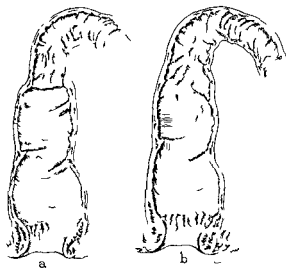
## THE TECHNIQUE OF ANTERIOR RESECTION OF THE RECTOSIGMOID<sup>1</sup>

BY FRED W. RANKIN, M.D., I.A.C.S.R., MINN. MINNESOTA

**R**ECTOSIGMOID is an anatomical name for a portion of the gastrointestinal tract which strictly speaking represents the continuation of the pelvic colon above into the rectum below but which surgically speaking represents a division of the large bowel which includes not only the last 5 centimeters of the sigmoid but the upper 5 centimeters of the rectum proper. It is the smallest part of the large intestine and possesses a mechanism whereby the fecal current is retarded or stopped so that normally the rectum is practically always empty. The rectum proper begins at the third sacral vertebra and extends to the top of the prostate in the male and to the perineal body in the female. Landmarks which correspond with the beginning of the anal canal. At the point at which the sigmoid enters the top of the rectum from the left side the direction usually changes thus making an angulation as the peritoneum covered colon merges into the retroperitoneal portion of the pelvis. The narrowing of the bowel at this point is not the only anatomical peculiarity of the anastomosis; there is a distinct difference in the mucous membrane of the two divisions of the large bowel that of the sigmoid being thrown into rugæ and appearing as distinct from the rectal mucosa as the gastric mucosa is distinct from the duodenal mucosa at the pylorus. This change in the appearance of the mucous membrane is characterized by an increased blood supply and a greater freedom of this internal coat of the bowel. There is no change in epithelium at this point in the gastrointestinal tract such as is noted lower in the anal canal which is lined with pavement epithelium and has no mucous glands (Fig. 1). It has not been definitely proved despite frequent assertions particularly in discussing the etiology of such vague diseases as megacolon that there is a definite sphincteric mechanism at the rectosigmoid. Unquestionably there is a distinct narrowing of this portion of the intestinal tube. Reeves in 1917 dissected out the rectum

and rectosigmoid in 46 cadavers and found that a terminal constriction was present in 86 per cent and that in two instances the narrowing was so definite as to reduce considerably the caliber of this portion of the bowel. More recently Martin and Burden in discussing the sphincteric action of the rectosigmoid observed that of 31 specimens examined 1 showed a distinct and abrupt transition in the appearance of the mucous membrane between the rectum and sigmoid in the others the transition was more gradual at varying distances up to 31 centimeters from the anus. Regarding the musculature at this particular point however they assert. As a rule the sigmoid has a well developed musculature exhibiting no local increment of circular fibers to suggest an anatomical sphincter nor is there a constant perceptible narrowing at the rectosigmoid junction. Anatomically this is a favorite site for neoplasms and its inaccessibility is proverbial among surgeons. Too high to be attacked readily by a posterior type of operation it is at the same time too low to be easily accessible by the abdominal route except in cases in which the anatomical conformation renders the difficulties less marked.

The acceptance of the postulate that all carcinomata that are extirpable should be dealt with radically not alone by their removal but by removal of the contiguous gland bearing tissues is well predicated a formidable procedure in dealing with malignancy in this situation. The lymphatic drainage involved in carcinomata of the rectum that are above the anal canal has been excellently worked out by Miles who divides the lymphatics which drain the rectum into intramural and extramural groups. The intramural group is found in the rectal wall one plexus is in the submucous tissues and the other is between the muscular coats. The spread in this group is unquestionably limited although there must be some spread in a small number of cases by this route. The extramural lymphatics are the more



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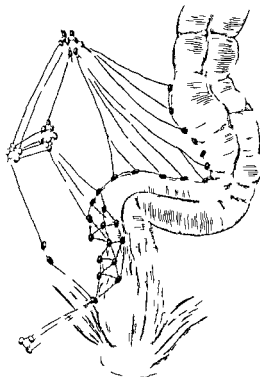
important from the surgical standpoint and are divided into zones as follows (Fig. 2)

1. The one of downward spread which includes the perianal skin and ischioanal fat and the external sphincter. This site is especially vital in cases of carcinoma of the anal canal. Only because of its anastomosis with the other ones need it be considered if the carcinoma is higher in the bowel.

The lateral one which includes the lymphatics between the levator ani muscles and the pelvic fascia and structure, the prostate gland, the base of the bladder, the cervix uteri and the base of the broad ligaments in women and the internal iliac lymphatics.

3. The upward zone which includes the pelvic mesocolon and the lymphatics situated at the bifurcation of the left terminal iliac artery as well as the aortic nodes. Miles considers the one of upward spread the most significant, an opinion in which many of his contemporaries, both foreign and American, concur.

In a recent brilliant and exhaustive article on carcinoma of the rectum, Pfeiffer notes the work of Villemain, Hurr and Montagne who offer a simpler anatomical division of the rectum on the basis of lymphatic distribution whereby the portion above the ileocecal valve of Houston is designated as the upper or pelvic rectum and the portion below as perineal rectum. Lymphatic injections in the lower part of the rectum spread upward to the last valve of Houston but not beyond while injections above the valve spread downward but are arrested at the valve. The



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point is made clear that there is no such limitation at the recto sigmoid, the efferent vessels being divided into groups corresponding to the arterial supply of the part: the superior lymphatics following the superior hemorrhoidal vessel and anastomosing with the abdominal group of lymphatics while the two lower groups, the middle and inferior, pass to the pelvic and lateral zones but anastomose with the internal and intra-abdominal lymphatics. The authors deduce that carcinoma of the upper part of the rectum should be removed by an operation exclusively abdominal, obviously the rectosigmoid is included in this classification. The drainage of lymphatics, as Broders puts it, is toward the mediastinum, and for this reason removal of the lymphatics behind the growth perhaps is not always essential in dealing with malignancy. That these tissues should be removed by wide radical resection compatible with a reasonable mortality rate and a satisfactory functional result is the aim of any operative procedure dealing with neoplasm in this situation.

Undoubtedly many cases of malignancy of the large bowel and rectum are best dealt with by graded maneuvers. When it is considered that the average patient with rectal carcinoma (in

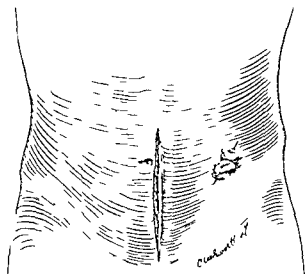


FIG. 3. Median line incision extends over the umbilicus giving ample exposure. The colostomy is shown and should be done 2 weeks in advance of the resection.

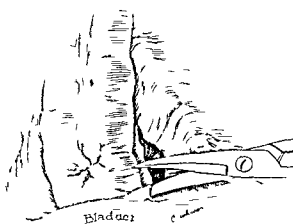


FIG. 4. Theitoneum is incised on both sides of the bowel through the umbilicus down to the bladder. This is a bloodless dissection and permits the identification of both ureters before the operation is carried further. Ample peritoneal space is obtained without difficulty in the majority of cases for the peritonealization of raw surfaces.

this group carcinoma of the rectosigmoid is like wise included) presents himself after symptoms have been present for a year the low percentage of cases accepted for any type of operation except palliation is not surprising nor is it strange that many patients who are submitted to the two stage or three stage operation are able to withstand more radical procedures with better end results than if the operation were undertaken at a single stage.

Chronic obstruction of the large bowel is a vital factor because of the accompanying rapid debilitation anemia and desiccation. The chronic absorption not only from the content of the intestinal tract but from the large ulcerating and infected surface of the growth causes a lowered physiological state and this has direct bearing on the outcome of any type of operation. Pentonitis bronchopneumonia and other post operative complications which result even from simple operative procedures instituted for the relief of obstruction or for palliation are directly the result of intoxication due to obstruction. Consequently one of the principal aims of operation is the eradication of the obstruction which perhaps is the most important rehabilitation measure indicated in the majority of instances and is partially accomplished before the first stage of the operation. Although it may be too radical to postulate that all carcinoma of the rectosigmoid and rectum should be operated on by the graded operation certainly such a procedure is required in the greater number of cases and only in selected cases should the more formidable but highly desirable one stage abdominoperineal resection be undertaken. In this selected group of cases the

abdominoperineal operation performed by the technique of James of Boston is ideal. A graded abdominoperineal or abdominoperineal resection permits of more radical procedures with removal of a wider area of infected tissue in a case in which otherwise the risk would be considerably greater. In the absence of metastasis to the liver and fixation to adjacent structures immobility is unquestionably the most significant criterion in the decision as to whether the growth is removable and this immobility is I believe more often the result of inflammatory than malignant changes. Given a drainage operation which permits local treatment and the institution of measures to reduce inflammation one not infrequently finds that a radical secondary operation may be carried out satisfactorily in cases which at the first stage were deemed unsatisfactory for resection.

#### PRE-OPERATIVE PREPARATION

The isolation of patients with surgical diseases of the colon and rectum under co-operative management in the Mayo Clinic has permitted not only proper pre-operative preparations to be instituted but with increasing experience has permitted better selection of cases for different types of operation. The rehabilitation measures instituted consist of (1) adequate cleansing of the gastrointestinal tract (2) supportive measures such as blood transfusion increase in fluid intake and general measures to increase the patient's resistance (3) institution of local measures which reduce the inflammatory reactions around the growth (4) proper dietary measures and (5) institution of drainage by colostomy preliminary



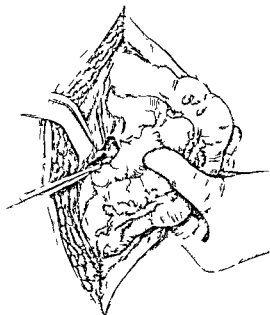


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to subsequent resection. The study of these cases and a comparison of immediate results over a short period have shown convincingly that conservative group management preoperatively and postoperatively with proper selection of anesthetic and a graded operative maneuver have added materially to the immediate satisfactory operative results.

The routine preoperative preparation of the bowel itself has consisted of (1) the institution of drainage prior to resection (2) the administration of small doses of castor oil in varying amount to within 48 or 96 hours before operation and (3) cleansing enemesis twice daily until 24 hours before the operation with large amounts of water until it returns clear and (4) during the day prior to operation Parego in divided doses of from 1 to 2 grams every 4 hours until 4 doses have been given. This routine almost invariably results in a clean empty bowel and the administration of the narcotic during the last 4 hours has had a decided sedative effect on peristalsis. A diet free from residue and consisting largely of fruit juices and candy has been found satisfactory. Increase in weight frequently has resulted and nutrition has always been adequately maintained.

#### CONCLUSION

Perhaps the most important advance in the treatment of carcinoma of the rectum and rectosigmoid has been the usual tendency to accept permanent colostomy as a necessary step in the procedure. Whether the operation is performed in one or two stages there is small reason for belief of the fact that most patients are better off with the colostomy opening on the anterior abdominal wall where it may be more satisfactorily attended to than posteriorly on the sacrum. In performing colectomy I prefer to explore the abdomen through a split muscle incision palpating the liver, aortic lymph node and the growth in the order named and determine the relative fixity of the growth in the absence of metastasis. The artificial anus is made as high as possible in the sigmoid rectum. The colon is fed back into the abdomen until its fixed point is reached and here an opening in the transverse mesocolon permits drawing under it of at least two layers of the abdominal wall, the skin and peritoneum. The small fossa lateral to the colon between its mesentery and the parietal peritoneum is shut off by a purse string suture to prevent herniation and obstruction from loops of the small

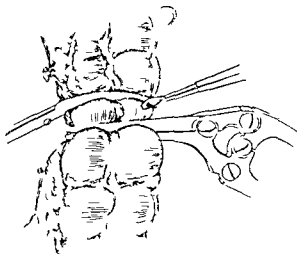


Fig. 2 Dividing the upper end of the bowel between clamps with cautery

bowel which might pass behind it. As the colon is fed back into the abdomen a point is reached which also prevents subsequent herniation of the mucous membrane of the bowel and makes it much easier to care for. I do not believe that sutures should be placed in the wall of the bowel. Occasionally fecal fistula results in spite of the care taken not to penetrate the lumen and if the peritoneum is drawn snugly around there is small question of necessity of the sutures. The peritoneum and the skin are sutured as separate layers under the bowel. A few interrupted sutures in the aponeurosis of the external oblique are all that are necessary except the subsequent approximation of skin. I have seldom observed hernia as a result of this type of operation. Control is likewise satisfactory so long as the bowels are constipated.

The colostomy is allowed to remain closed as long as the patient does not complain of gas distention and frequently gas passes over the stoma and out by rectum for as long as 10 days. Usually, however, one must cut across the bowel or at least puncture it to obviate painful distention. One may make this incision any time after 48 hours up to 7 days and then institute through and through irrigations with the idea of cleansing the lower loop of the bowel and reducing infection as much as possible in preparation for the secondary resection. Either physiologic sodium chloride or weak permanganate of potash solution is satisfactory for irrigation. Probably the removal of the content of the bowel and the thorough washing of the ulcerated and infected area account for the reduction in inflammatory reaction rather than the use of any particular medicament which may be placed in the solution. At the same time rehabilitation measures are forced and the patient

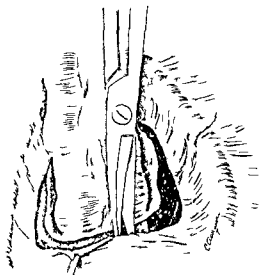


Fig. 3 Lifting the bladder from the rectum in the male and dividing the peritoneal fold which attaches them

comes to operation in an infinitely improved state from the delay of two weeks and the institution of drainage.

#### TECHNIQUE OF RESECTION

Usually it has been found advisable to wait from 10 days to 2 weeks after the preliminary colostomy has been performed before the second maneuver of the resection is carried out. The abdomen is opened through a long median line incision which extends to the left of the umbilicus and about 2.5 centimeters above it (Fig. 3). To prevent contamination as much as possible the stoma is sealed off before operation is begun and

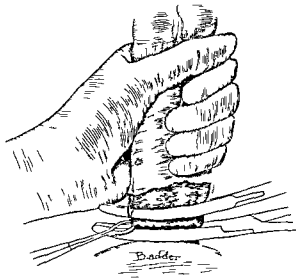
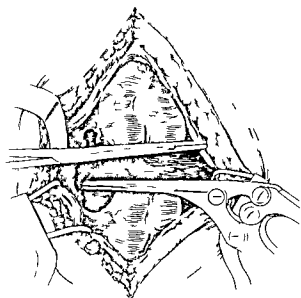
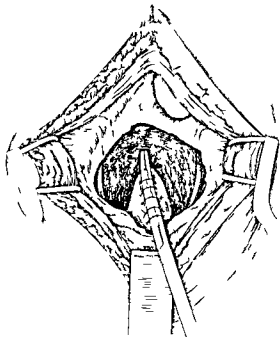


Fig. 4 Division of the lower end of the bowel between clamps with cautery



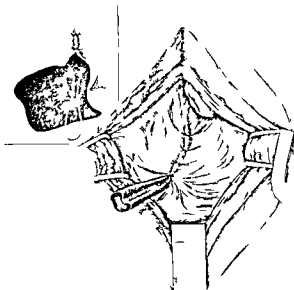
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I believe it is rarely a source of contamination except by superficial wound contamination which is a rather constant accompaniment of any procedure carried out on the large bowel. After the



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abdomen has been opened and its contents in the upper quadrants except the pelvic colon and contents of the pelvis picked away, the initial step to insure satisfactory hæmostasis is ligation of the inferior mesenteric vessels near the promontory of the sacrum (Fig. 4). The inferior mesenteric artery should be ligated between the superior hæmorrhoidal and the left colic branches in order to preserve adequate vascular nutrition to the left colon. The whole of the descending colon, sigmoid and upper part of the rectum derive their blood supply from this artery. It is fairly constant in its distribution, save only for its anastomosis with the superior mesenteric which fail occasionally and results in necrosis of the left colon. The arteries of the sigmoid which are branches of the inferior mesenteric vessels anastomose with the superior hæmorrhoidal and left colic arteries and are not sufficiently disturbed to interfere with the blood supply of the upper part of the sigmoid after a ligature has been placed between the left colic and superior hæmorrhoidal vessels (11, 5). In ligating the left colic vessel one first retracts the colon toward the left side and incises the peritoneum of its mesentery over the vessel. This exposes the vessels readily and they may then be isolated on a finer. Careful manual



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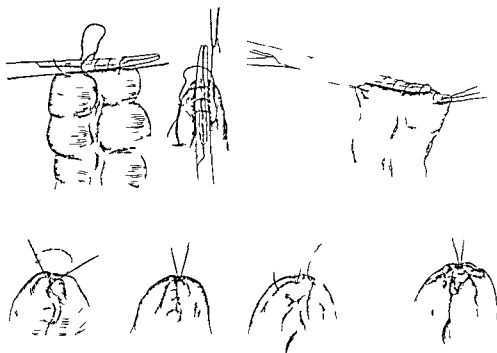


Fig. 13. Steps in the closure of the upper end of the sigmoid. The incision is closed with a suture. This is inverted and factored into a loop on the left. Ordinarily it is better removed as is shown in Fig. 14 and 16.

manipulation of the vessels isolating them together is I believe preferable to elevating them on an aneurism needle or other instrument and is less rarely accompanied by tearing into the vein with resulting venous hemorrhage. The vessels should be freed of fat and carefully ligated twice to prevent them from retracting into the mesentery with ensuing hemorrhage or at least a large and undesirable hematoma. The initial incision on the right side in the peritoneum of the mesentery of the pelvic colon is now carried forward to the bladder with retraction laterally to expose the right ureter. A similar incision is made on the left side after the sigmoid is retracted toward the right and the left ureter is likewise identified (Fig. 6). I believe the identification of the ureters is an important step and if possible should always be observed.

When both ureters have been identified and the blood supply has been ligated the dissection of the hollow of the sacrum follows easily and is readily done with the hand. If the hand is introduced at the point of ligation of the inferior mesenteric blunt dissection may be carried back to the fascia covering the hollow of the sacrum and the dissecting fingers carried forward and downward until they may be felt to jump off the end of the coccyx. This is about as low as posterior dissection may be done. It is surprising how infrequently there is any bleeding accompanying this step. Except for a few veins which

are sometimes troublesome whether one does an anterior or posterior resection there is rarely any bleeding and never any of consequence. A hot salt pack placed in the hollow of the sacrum once its contents are dissected controls any oozing which may be present.

The next step in the procedure is to free the sigmoid from its peritoneal attachments to the bladder. Starting on the right side with scissors dissection I cut across the peritoneum which joins the two viscera and separate them readily. If the ureters have been identified previously there is no question of injury either to them or to the base of the bladder itself (Fig. 7). Occasionally a sigmoidal growth will be found attached to the posterior wall of the bladder and it is necessary to take away the outer coats of this viscus in the dissection. If the mucous membrane of the bladder is not opened there is no complication from this step. After the attachments of the vesicosigmoid have been separated by blunt dissection laterally and anteriorly, the rectosigmoid and upper part of the rectum are freed down to a point within from 5 to 7.5 centimeters of the anal orifice (Fig. 8). It is surprising how far down one may carry this dissection and remove practically the whole of the rectum with the sigmoid leaving only a small stump. It is advisable to do the complete dissection in most instances before the sigmoid is cut across at its upper end yet when the growth is attached and dissection is some



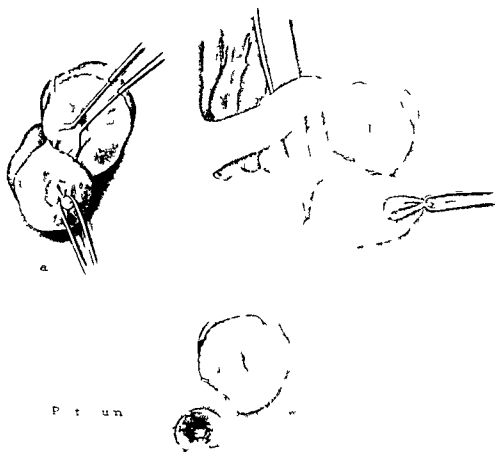


Fig 16 a Division of the mesentery and separation of the loops of bowel with cautery b Blunt dissection with handle of knife separating lower segment which is to be removed from skin and underlying tissues c Appearance of wound from which lower loop was excised immediately after its removal

hang *in situ* for about 10 days when it is removed easily and simply by cautery. I believe that this step while possibly making the operation a little more serious may not be unwise since there is a question of the blowing out of the end and the producing of peritonitis (Fig 16). This has been observed occasionally and apparently was a factor in the one death in my series of 26 cases.

#### RE ESTABLISHMENT OF THE LUMP OF THE BOWEL AFTER RESECTION

The question of re establishment of the continuity of the bowel following resection is one which the surgeon is forced to decide in each case because of the almost universal insistence by the patient that the muscular mechanism controlling defecation be preserved and the colostomy be abandoned subsequently. Occasionally a patient is so insistent that operation is refused unless this requirement be met and if the growth is above the peritoneal fold and there is no lymphatic involvement perhaps one is justified in restoring

the normal intestinal canal occasionally. As a working rule unquestionably carcinoma at the rectosigmoid and below is best treated by colostomy high in the sigmoid and subsequent removal of the entire bowel or at least all except the anal canal below the stomach. Anatomical types influence this decision markedly however and no one standard operation is applicable to all cases in this group. Individualization occasionally will demand after colostomy re establishment of the continuity of the intestinal tract. The important technical question in deciding this is the blood supply to the lower segment. After the inferior mesenteric vessels have been tied above the superior hemorrhoidal branch practically the whole blood supply to the lower segment and the rectum is sacrificed and yet studies of the collateral circulation and actual clinical experience bear out the observation that if a portion of the rectum is saved and the continuity re established if the blood supply to the upper segment is adequate necrosis and sloughing will rarely result. In this

series of anterior resections I re-established the continuity with bowel in only one instance. The patient was the wife of a physician and both she and her husband insisted that this type of operation be carried out. Unfortunately there was no lymphatic involvement discovered at resection and it seemed not unwise to agree to their demand. The re-establishment is not difficult (despite the fact that the lower loop is deep in the pelvis) and may be accomplished quite accurately with two or even three layers of sutures with a good outlook for success. The fact that there is no tension on the suture line from the colostomy opening alone and that any secretion in the segment may be removed by a rectal tube is decidedly advantageous to healing and with the exception of infection which is outside the lumen of the bowel there are few factors which prejudice success. As a general rule however the anastomosis should be depicted but unquestionably there are occasional exceptions favorable for its use.

#### EXISTENCE OF RECTAL TUMOR AT THIRD STAGE

A further modification which has been employed several times in this series of cases is the removal of the blind pouch of rectum as a third stage to the operation. It is not certain whether this step might not be employed as a routine; the only argument against it being the long morbidity which in reality is not an argument in dealing with carcinoma. It makes the operation more radical and prolongs the convalescence but it has been advantageous in the few instances in which I have done it. The first time it was necessary to remove the stump days after the second operation. An abscess formed in the pelvis making drainage highly essential and the easiest way to establish it came to be by extension of the rectal stump. This was done under general anesthesia and was a simple procedure requiring only a few moments. Suture was not used and the wound healed readily. Perhaps it will be an advantageous addition to the entire procedure at a third stage under local anesthesia. There has been practically no trouble from this stump when it has been left in situ and in only instances in the 20 cases did it drain into the sinus established by the abdominal drainage tube. In both instances the drainage tube was which followed irritation of the rectum and healed without incidence.

#### ANESTHESIA

Spinal anesthesia was employed as a routine in the series. Its advantages are so marked that its

continuance is at least indicated in this type of operation. The freedom from pulmonary complications, the relaxation and the lack of oozing at the time of operation facilitate more satisfactory exposure and accurate technique.

#### SUMMARY

From March 30, 1927 to February 1, 1928 I performed 26 anterior resections of the rectosigmoid and upper rectum by the technique described with one death. In this instance the patient was a man aged 68 with an easily removable growth. He died on the fifteenth day after operation after having been out of bed for 2 days and without symptoms referable to the abdomen. His bowels were active, he was eating well and his progress seemed perfectly satisfactory until he was seized suddenly with symptoms of abdominal crisis and died 6 hours later. Necropsy disclosed plastic peritonitis which probably is present to a certain degree in practically all of such cases. There was no other satisfactory explanation for his death.

My experience with this series has been so satisfactory from the standpoint of the technique as well as operative mortality and morbidity that I am encouraged to continue this type of operation either alone or with the modification suggested, namely removal of the lower segment either at the same stage or as a subsequent separate maneuver. Certainly it seems justifiable to hope for encouraging end results in the light of the radical procedure made possible by the multiple stage operation. The reduction of mortality is a striking example of what may be accomplished by co-operative measures in this group of cases and the adequate rehabilitation measures combined with spinal anesthesia and graded operation apparently encourage the prospect of a wide spread removal of the growth and continuous tissues with a lower death rate and a favorable outlook.

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## FROM THE DIVISION OF SURGERY JACKSON CLINIC

## THYROIDECTOMY

BY ALFRED S. JACKSON, M.D., M. A. N. W. S. N.

NO single condition is responsible for the dangers and possible complications to be feared in performing thyroidectomy. A number of factors should be considered such as the age of the patient, the duration of the disease, the extent of impurment of the cardiovascular renal system, the condition of the patient, the kind of goiter, the skill and experience of the surgeon, and the choice of anæsthetic.

Until 1922 when Plummer suggested the use of iodine in connection with surgery in the treatment of exophthalmic goiter, postoperative hyperthyroidism was the most dreaded of all surgical complications. Frequently, in spite of weeks or months of preparation and multiple stage operations performed with acumen and skill, the patient developed a high pulse rate and fever together with vomiting and delirium and succumbed a few hours after operation. Since 1922 no deaths have occurred at the Jackson Clinic as a result of postoperative hyperthyroidism in spite of the fact that only one ligation has been performed during the past 4 years. There have been a number of instances of severe reaction but in every case this condition has been controlled by the methods which I shall describe.

In exophthalmic goiter, the most fearful complication in my experience and probably in the experience of every surgeon interested in surgery of the thyroid is that of involvement of the recurrent laryngeal nerve. In some instances the surgeon is probably not directly responsible because the mere stretching or compression of the nerve by œdematous or scar tissue may cause trouble. Since it has been determined that failure in the past to effect cure for this disease was due to the preservation of too much gland tissue, most surgeons are now advocating a more radical removal of the gland. Consequently there is greater danger of involving the nerve either by a hemostat or suture unless care is exercised to remain within the capsule. This expression has become almost stereotyped in descriptions of the operation for goiter and might perhaps well be discarded. In many cases of exophthalmic goiter the gland is so friable and vascular and the capsule so thin that it is scarcely visible and the surgeon is fortunate to be able to resect the gland and control hæmorrhage. In adenomatous goiter

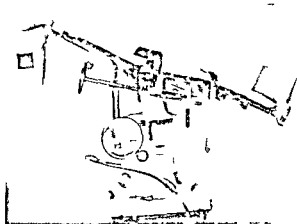
there is frequently a tough fibrous capsule and the operation is a much simpler procedure.

Two of my patients were successfully operated on in five minutes to converse freely before leaving the operating room. A few minutes later they were reported to be cyanotic and dyspnoeic. Unconsciousness quickly followed but the condition was promptly relieved by removing the bandage and cutting the jaw and forcing the chin down on the chest and administering oxygen. Convalescence was uneventful, a secondary wound closure being made 4 hours. Since laryngeal examination showed no involvement of the vocal cords and the trachea was not collapsed, these near fatal complications have been attributed to sudden paralysis of the nerves from change of position and consequent severe tension.

If only one recurrent laryngeal nerve is injured the other will usually compensate so that after a few days or weeks the voice is restored to normal. Even if bilateral adductor paralysis of the vocal cords occurs, tracheotomy may not be necessary, but if bilateral adductor paralysis occurs the increasing stridor, cyanosis and dyspnoea necessitate this procedure. There should be no excuse for the occurrence of such a complication yet there have been many instances in the past and with the increasing number of inexperienced surgeons performing the operation there will be more in the future. Too frequently this complication has been considered as tracheal collapse, a condition I have yet to observe.

Barring nerve injury, then death should not occur following operation for exophthalmic goiter unless it is from tracheitis developing into pneumonia or from hæmorrhage or the more unusual complications such as embolism, tetany and tetanus. In spite of preservation of the tracheal fascia and of care in handling fatal tracheitis may occur. Hæmorrhage although it is frequently severe at the time of operation in the large friable vascular glands of long standing is seldom dangerous and usually is controlled by elevation and compression of the gland by the index finger. Injury to the lateral or jugular veins may prove more troublesome. Postoperative hæmorrhage is evidenced by restlessness, dyspnoea, cyanosis and increasing pulse rate. The diagnosis is made by examination of the neck which usually





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has a full on ex rather than a c negative appearance

Cardiac failure is seldom a contraindication in exophthalmic goiter except in case of fulminant form. The condition of the heart can usually be regulated by iodine and digitalis. In thyrotoxicosis however chronic myocarditis is the not important condition to be considered and cardiac failure is the complication to be most feared. Hence when the disease is of short duration the surgeon experienced the anaesthesia local and the preoperative preparation correct the patient obviously has an excellent chance for recovery and no complications should be feared.

## PRECURSIVE PREPARATIONS

The preoperative preparation of patients in these cases depends on the kind of goiter and the condition of the patient. In nontoxic adenomatous goiter, no preliminary treatment is required other than to determine that no contraindications to operation exist, such as diabetes and tonsillitis. However, since extremely large adenomatous goiters frequently obstruct the trachea and consequently exert considerable back pressure on the heart, it may be advisable to give the patient a general laxative, rest in bed and to give digitalis.

In the United States it is a different story. At the present time there exists a greater divergence of opinion in our country in the preparation of these patients for operation than at any time in the past. It makes little difference what method is used as long as the most skilled hand there is a definite mortality of from 1 to 5 per cent. The care of the patient is the most serious problem confronting the surgeon who is especially interested



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ed in g iter surgery. Until about 1960, years ago, a lummer advocated the routine digitalization of these patients. Then he stopped the use of digitalis and stated that a considerable lowering of the mortality had resulted. Some have felt that actual clinical experience warranted the continuation of the use of digitalis. Among the institutions supporting this view are the Cleveland Clinic, Lahey Clinic, Henry Ford Hospital, University of Michigan, and the Jackson Clinic.

During the past year four deaths have occurred following operation for goiter in our Clinic. Two of these patients had toxic adenoma of long standing in which serious damage to the cardiovascular systems had occurred. I have often wondered whether if digitalis had not been given these patients would have survived. Likewise I have wondered whether some of the other patients who presented equally poor risk would have survived if digitalis had not been used.

There also exists great difference of opinion regarding the use of iodine in these cases. Crile, Graham and others who support the view that exophthalmic goiter and toxic adenoma are one and the same give iodine. In my own experience I have not found iodine beneficial in cases of uncomplicated toxic adenoma. I believe that seeming success has been due to the fact that in one of every four cases of exophthalmic goiter adenomatous nodules may be found. In other words a patient may have adenomatous goiter for many years duration that has never become toxic. A few months before he consults his physician exophthalmic goiter is superimposed. Iodine is

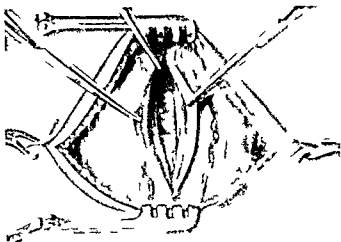


Fig. 3. Median incision through the fascia and muscle to the gland.

given supposedly for toxic adenoma and there is immediate improvement. This error will continue to be made until the clinical differential points between exophthalmic goiter and toxic adenoma are clearly understood. Rest in bed, a high caloric diet, sedatives, and general symptomatic treatment are indicated. No patient should be allowed to become bedridden but after a few days absolute rest should be encouraged to walk around and build up for the operation.

The use of iodine has revolutionized the pre-operative preparation of patients with exophthalmic goiter. Four years ago I gave up ligation and stage operation and whenever possible allowed the



Fig. 4. The gland is exposed into the superior pole after the muscle is divided and the gland is exposed.

patient to go home for operation at home. This is not so useful as preparation in the hospital since the conditions are necessarily not identical but it is a great financial help to the patient. Many patients of course must be hospitalized and even kept in bed for several days if there is cardiac decompensation or gastro-intestinal crisis. The old idea of keeping these patients in bed for weeks is wrong. No matter in what condition my patients come I never permit more than a week's rest in bed. Ninety per cent of them are operated upon within 10 days from the time they are



Fig. 5. Separation and ligation of lateral veins (one of the most important steps of the operation).

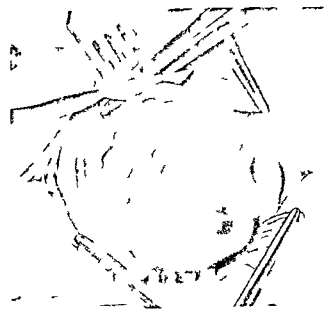
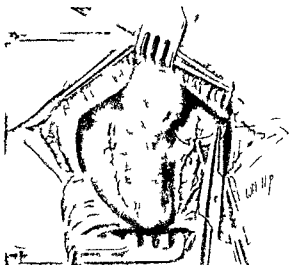


Fig. 6. Double clamping of the superior thyroid vessels and division of pole allowing easy mobilization of the gland.



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admitted. In 1923 I showed that the average drop in the basal metabolic rate within this time was 50 points provided large doses of iodine were administered. I have always maintained that more satisfactory results could be obtained in a shorter time by saturating the gland with iodine than by merely using 15 drops a day. In the average case 60 drops a day is given but two or three times this amount may be used for patients admitted in crisis. All my patients receive a high caloric diet (about 4,000 calories a day). Only the use of coffee and tea is restricted. They may eat all the beefsteak, all the cake and candy they want and in fact anything they desire so long as they eat.

Patient are routinely given 30 drops of the tincture of digitalis three times daily for 3 days. A half grain of phenobarbital is given three times daily. These drugs are not essential but are a matter of individual choice.

Next to iodine therapy I believe that the psychologic factor is most important in handling the patients. I never operate unless the patient fully understands his condition and knows the time and reason for operation. He gains confidence by talking with others who have undergone operation. Crile employs another form of psychology—that of stealing the gland. Both methods apparently yield equally good results but it should be understood that these patients cannot be handled by or line a method. It is the little things that make the big things in gouter surgery.

It is a mistake to starve these patients on the morning of operation. If iodine and food are withheld for several hours before operation it is

only natural to suppose that the metabolism will be greatly increased that the postoperative reaction will be severe and that acidosis may occur. Our patients receive 50 grams of glucose with orange juice as is given to diabetic patients an hour before operation and iodine is administered continually.

#### THE OPERATION

When the patient's condition has been judged fit for operation, he is so informed and perhaps is given an additional sedative on the night preceding operation. An hour before operation 4 grain morphine is given hypodermically and 15 minutes later 1/300 grain of scopolamine. The room is darkened and no relatives are permitted to come in. The patient's eyes are bandaged, aselined cotton is inserted in the ears and he is encouraged to sleep. When he is brought to the operating room 1/6 grain of morphine is given hypodermically. This usually insures perfect anesthesia when combined with novocain.

The position of the patient on the operating table is of considerable importance. I recently devised a table that I feel gives the best exposure of the operating field and at the same time assures the maximal amount of comfort for the patient (Fig 1). The preparation of the skin is a matter of individual choice and it makes no difference

whether iodine picric acid or mercurochrome is used. Opinion is about equally divided regarding the anæsthetic some surgeons prefer nitrous oxide others ethylene and still others novocain. In my experience the latter following hypodermic injections of morphine and scopolamine has given excellent results in fully 98 per cent of my cases this method has been used. The advantages are that the surgeon has the patient under his control the patient can be made to talk and to cough the possibility of injury to the recurrent laryngeal nerve is consequently lessened the danger of post operative pneumonia is almost eliminated and in the case of removal of large substernal goiter dyspnoea is better controlled. The disadvantages are that if the patient is extremely apprehensive the operation is more taxing both on the patient and the surgeon. In my experience non toxic patients are frequently more nervous than the extremely toxic patients. Postoperative vomiting and reaction are materially reduced by the use of local anæsthesia. The infiltration method is preferable to nerve block because it is simpler and more speedy. One half of 1 per cent of novocain with no adrenalin is satisfactory. An all metal modified Meeker syringe that I have devised has proved helpful (Fig. 1).

In thyroid surgery perhaps more than in any other teamwork is essential and the service of two skilled assistants is desirable. Likewise the surgical nurse should be unusually keen and alert since accuracy and intelligent co operation may play an important part in the success of the operation. There is no talking during the operation and quiet is secured by covering metal surfaces in the operating room with rubber.

The instruments required for the usual goiter operation are several dozen Kocher (large or small) Crile or Lahey hæmostats as preferred one dozen small curved clamps a grasping clamp (Fig. 2 C) sharp and dull retractors a self retaining retractor four muscle clamps two needle holders one dozen towel clips and four sharp scalpels.

When the incision is made the scalpel must be carried at right angles to the skin the entire distance otherwise the upper flap will override. The incision should if possible be made in a fold of the neck and should be fully an inch higher than is ultimately desired for the scar. The length of the incision will depend on the size and consequently the type of goiter. It should be slightly curved and its lowest median point should be at least an inch above the suprasternal notch. (Some surgeons prefer to outline it first with a colored solution or the back of the knife.) The incision should be made with a free clean sweep and made

at once through the skin the platysma myoides and to the superficial facial layer. The flaps are then dissected free to give adequate exposure and the superficial bleeding points are ligated. Among the various types of self retaining retractor to hold the flaps in place is one which I have devised for this purpose (Fig. 2 B). A split towel protects the wound. Occasionally it may be advisable to ligate separately the external jugular veins. A median or slightly lateral incision is then made through the cervical fascia and underlying muscle to the thyroid gland. The sternohyoid and sternothyroid muscles are next elevated from the capsule of the gland by blunt dissection. Whether or not these muscles are to be divided is a matter of individual choice. In many cases I prefer to divide them as I feel that the greatly improved exposure more than compensates for the time lost. Haste is less essential than is a careful resection of the gland. If the goiter is large or friable and vascular there is danger of injury to the nerves or parathyroids if there is inadequate exposure. In many instances it may be necessary to divide the muscles on but one side. Novocain should be injected into the muscles before they are divided.

When the gland is exposed it should be injected and then elevated. At the same time the capsule should be separated by either blunt or sharp dissection. Care should be exercised to avoid tearing the lateral veins and these should be separately ligated. The gland having been freed from its bed the upper pole is exposed and the superior thyroid vessels located. These are double clamped and then divided. Whether or not the vessels are secured by means of an aneurism or a regular needle is immaterial and whether plain catgut or silk is used is merely a matter of choice. The important point is to ligate the vessels securely so that they cannot retract and cause hæmorrhage. When the upper pole has been divided the gland is easily mobilized. Some surgeons now prefer to free the gland from the trachea a procedure that should always be carried out in case of large substernal goiter. Others prefer to proceed by placing hæmostats laterally on the gland after the method of Halsted. It is a safe plan to leave some gland tissue below the clamp at the lower pole. The gland is then resected the assistant clamping the vessels as they are about to be divided. The amount of tissue to be preserved depends on the type of goiter a much smaller portion is preserved in the exophthalmic type than in the others. Next the vessels are ligated and a few interrupted sutures may be used to control the hæmorrhage. If the isthmus has not already been resected this

is now done and the same procedure carried out with the left lobe. The tracheal fascia should be preserved intact since its removal leads to distressing tracheitis.

After the gland has been resected the patient is asked to cough and strain so that any possible bleeding points may not be overlooked. If the wound is dry the divided muscles may be approximated. In uniting these muscles in the median line interrupted sutures and separate closure for the fascia are preferred (Figs 3 to 5).

There is considerable difference of opinion regarding the question of drainage. I am convinced from the experience of others and from observation that some kind of drain should be inserted because of the danger of infection and of mediastinitis. Some surgeons prefer lateral to median drainage, some prefer rubber tubes and others gutta percha. Some likewise advocate silk in skin closure, others suturel and still others clips. I have tried all methods of drainage and skin closure and have no particular preference. Apparently an interrupted closure of the platysma muscles and of the skin gives better results (Fig. 5). Too much care cannot be exercised in an effort to produce a perfect scar. The type of dressing used is immaterial as long as it is comfortable and sufficient to protect the wound and prevent staining from drainage.

It seems almost unnecessary to say that the trachea should be handled with the greatest gentleness. A thyroidectomy cannot be successfully performed under local anesthesia unless this surgical principle is observed.

#### POSTOPERATIVE CARE

The patient should be placed in bed in a semi-upright position and made comfortable with plenty of pillows. Lap water is given routinely by proctolysis in case of exophthalmic goiter. No drop of liquid solution is added to each 500 cubic centimeter of tap water. In these cases it is essential that sufficient iodine be administered both by mouth and by rectum to control the postoperative reaction. During a period of 6 hours before and after operation my patients receive 100 drops or more of iodine well diluted. The amount given thereafter depends on the severity of the disease and the severity of reaction. Vomiting, tachycardia, fever and restlessness may all be present but when they are exaggerated a severe reaction is indicated. The proper preoperative preparation and the use of iodine will control all these symptoms.

Toxic adenoma offers a more difficult problem. The operation may have been performed speedily

and with little apparent disturbance to the patient. The latter returns to the room seemingly in good condition. The next day the pulse rate may be irregular, the patient's mind rather cloudy and in spite of all efforts to the contrary another day may see the fatal termination of the case.

It does not seem necessary to say that the intake and output of fluid should be carefully observed; that in case of tracheitis a steam tent should be placed around the patient and that excessive mucus may be controlled by administration of codein and small doses of atropin together with digitalis hypodermically. I thenobarbital and codein will usually control nervousness if this fails morphine may be given.

#### POSTOPERATIVE COMPLICATIONS

Since the most frequent postoperative complications have already been discussed it is necessary to mention only the treatment of these conditions.

*Injury to recurrent laryngeal nerves.* If one recurrent laryngeal nerve has been injured temporary loss of voice usually occurs. More distressing are the dyspnea and mucus. Codein, atropin and steam inhalations of benzoin are helpful. If both nerves are damaged so that bilateral abductor paralysis of the vocal cords occurs it will probably be necessary to perform tracheotomy.

*Hæmorrhage.* As soon as hæmorrhage is suspected the patient should be returned to the operating room if time permits. There the wound may be opened under ideal conditions, the blood clot removed and possibly the bleeding vessel ligated. If the vessel cannot be readily located without risk of injury to the nerves the wound should be packed and left open for secondary closure.

Every interne and nurse coming in contact with goiter patients should be familiar with the signs of postoperative hæmorrhage since prompt action may save a life. Dyspnea may develop so rapidly that it is necessary to remove the bandage and open the wound with whatever is at hand. Prompt action and the administration of oxygen are indicated.

*Tetany.* Postoperative tetany, an unfortunate complication especially if it is the chronic type. I recently made a study of this subject and reported several cases (2) in the hope that it might stimulate an interest in this problem and possibly lead to more satisfactory methods of treatment. It is evident that the radical type of thyroidectomy necessary to obtain cure and prevent recurrence

has resulted in an increased incidence of postoperative tetany. Practically every surgeon that has performed a considerable number of thyroidectomies has encountered this complication and yet considering the enormous amount of literature on goiter this subject has received but slight attention. There seems to be an inclination not to discuss unsatisfactory results.

The onset of postoperative tetany may be acute or chronic. Headache radiating pains down the extremities, chronic twitching and stiffness in the hands and feet are early symptoms. The extremities tingle and become numb, the face becomes stiff and distorted, spasms develop in the hands and often in the feet. The hands may assume the typical contraction of the accoucheur's hand. The diagnosis may be confirmed by eliciting attack through pressure over the main nerve trunk of the forearm (Trousseau's sign) or by tapping the facial nerve and causing the muscles of the corner of the mouth to twitch (Chvostek's sign).

In my experience calcium administered either orally or intravenously has proved entirely satisfactory in controlling the attacks of tetany in all but one patient. In this case Collip's parathormone injected intravenously proved most beneficial. In the five chronic cases which I reported neither of these remedies effected cure. However one patient has shown remarkable improvement following ultraviolet light therapy and I have been sufficiently encouraged to follow this lead.

**Embolism.** Fortunately embolism is a rare complication in surgery of the thyroid. I know of two fatal cases of air embolism, one following ligation and the other following thyroidectomy. It should be borne in mind that the veins of the thyroid do not readily collapse and that they are valveless and consequently air is quickly aspirated. All bleeding points should be securely ligated.

**Pneumonia.** If operation is done under local anesthesia pneumonia can be almost excluded as a complication and now the advent of the oxygen chamber promises to reduce still further the dread of this complication.

**Infection.** The incidence of infection following thyroidectomy is considerably lower than in abdominal surgery. In fact if proper drainage has been supplied infection rarely occurs. I believe that the wound should be probed daily at the site of the drainage tract and the neck lightly massaged. If the neck appears indurated and firm proper drainage is not being secured and moist warm dressings should be applied at frequent intervals. If pus appears healing is naturally delayed and a disfiguring scar may result.

## PROGNOSIS

If sufficient tissue has been removed, a recurrence may be expected in not more than 1 per cent of cases of adenomatous goiter. This factor is dependent on age, the younger the patient the greater the possibility of recurrence. Usually solitary cystic adenoma will enlarge and if detected early may be removed through a small incision. Adenoma in the region of the isthmus beneath the mandible or behind the trachea are frequently overlooked and are the cause of recurrence. Naturally when only lobectomy has been performed there is a strong possibility that recurrence will result. Some surgeons have stated that in resecting the gland it is necessary to remove all adenoma. I consider this impossible unless complete thyroidectomy is attempted, since in many instances the entire gland appears to be made up of minute adenoma.

A higher incidence of recurrence may be expected in exophthalmic goiter. In 1906 I assisted Judd in reviewing the postoperative results in two selected groups of patients operated on for goiter at the Mayo Clinic. It was possible to trace 90 of 100 patients who had been operated on for exophthalmic goiter. 66 per cent of these were free from all signs of the disease 6 years after operation, 13 per cent were markedly improved and 5 per cent were slightly improved. Eleven of the patients died after leaving the Clinic. These operations were all performed before Lugol's solution was being used and on account of greater risk it was not always possible to remove as much tissue as can now be done. Recently I made a study of 300 cases of patients with exophthalmic goiter on whom I had operated and although the time elapsed is too short to pronounce cure in only one case did the patient state that no improvement had resulted. In 95 per cent they reported that they were cured or greatly benefited. The remainder stated that their condition was improved. A number of these cures resulted only after a second thyroidectomy, the primary operation having been performed either by other surgeons or by myself. This should be encouraging for the surgeon and should refute the claims that exophthalmic goiter cannot be cured by thyroidectomy. In my opinion however cure does not mean operation alone but includes a careful post-operative regimen for a year or more.

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## DERANGEMENTS OF THE KNEE JOINT WITH SPECIAL REFERENCE TO THE RÔLE OF THE INTERNAL ALAR LIGAMENT IN TEARS OF INTERNAL SEMILUNAR CARTILAGES

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**A**LTHOUGH there is quite an extensive literature dealing with internal derangements of the knee joint the subject is always of interest to surgeons not only because these derangements are constantly met in industrial surgery demanding correct recognition and treatment but also because the newer phases and different aspects from which derangements of the knee joint can be viewed are matters that are of an interesting and considerable discussion.

Derangements of the knee joint were recognized long before the era of the roentgen ray. As early as 1477 William Bromfield described the existence of cartilaginous bodies in the knee and William Hall and John Hunter were also early contributors to this field of pathology.

The roentgen ray has not been of very great service in adding to our knowledge of internal derangements of the knee joint. The roentgenogram is of value only when gross bony or dense cartilaginous changes exist but for investigation of displacements of the semilunar cartilages and in derangement which are brought about by changes in the supporting ligamentous structures and the synovial membrane the roentgen rays actually offer but very limited assistance.

Study of the knee joint has been carried out by most investigators in preserved limbs. The operating room offers but little opportunity for exact study of the tissues *intra vitam* since in knee joint surgery it is imperative to avoid all unnecessary manipulations. Therefore in order to study the structures and tissues in a condition approximating those in the living subject it is necessary to carry out the anatomical investigations in the cadaver before post mortem changes have taken place.

For the foregoing reasons and in order to obtain reliable data on knee joints were studied soon after death. An attempt was made to simulate the various traumatic derangements and to visualize the mechanical effects upon the joint. It is only through a proper understanding of the anatomical structures of the knee joint their relation to one another and the pathology considered in the light of a careful clinical history that a diagnosis of a torn cartilage can be established.

### ANATOMICAL CONSIDERATIONS

In proportion to its size the knee joint is the most loosely constructed of all the joints. This applies to its bony architecture. The parts of the articulation which are apposed to one another are the spine of the tibia and the intercondylar notch held together by the crucial ligaments. The articulation when deprived of its supportive or binding structures becomes unstable in every position and depends therefore for its stability and integrity upon the ligaments and muscles which bind it. The articular surfaces of the tibia and femur do not come in contact over a large area in any position and in full extension a considerable space is created on either side of the joint on account of convex surfaces of the femoral articulations. These spaces are filled in by the semilunar cartilages—two crescentic disks broad on their external surface and tapering internally decreasing in thickness so as to form a wedge. The semilunar cartilages stabilize the knee when it assumes the extended position and so prevent it from bending laterally. This stability is reinforced by the lateral ligaments—the internal lateral ligament aiding, the external semilunar cartilage and the external lateral ligament aiding the internal cartilage. The semilunar cartilages as the name implies are semicircular remains of a complete interarticular fibrocartilaginous disk with its center worn through (Whitlocke) so there are left sharp free edges directed toward the center of the joint. The peripheries are thick and are attached on their external surface to the capsule. Both lose the cartilaginous character at their extremities and become fibrous. It is at this fibrocartilaginous junction that fractures or tears usually occur. The attachments of the semilunar cartilages are important from the traumatic standpoint. The internal cartilage is attached in front by the coronary ligament—a modification of the capsule to the non-articular surface of the tibia immediately in front of the tibial attachment of the anterior crucial ligament and in addition by the transverse ligament to its fellow on the opposite side. Bristow calls attention to the difference in length of the two coronary ligaments and believes that the frequency of displacement of the internal cartilage is due to the immobility of that cartilage as a result of its more firm fixation by the

**coronary ligament** The external coronary ligament is 10 millimeters in length, while the internal is 6 millimeters in length. This suggests to Bristow that the external cartilage is allowed more mobility than the internal and is possibly a factor concerned in the relative infrequency of damage to this meniscus. The security of the anterior cornu of the internal semilunar cartilage is often exaggerated since that particular portion of the cartilage is more or less free.

The external surface of the internal semilunar cartilage is firmly fixed to the inner portion of the internal lateral ligament and also throughout its external border to the capsule. This area of fixation appears to be the point of contention to many observers and is held responsible or at least as a contributing factor in the injury of that cartilage. Tenny, Sir Robert Jones, Henderson, Fisher and others are firm in this belief. The fact that the internal semilunar cartilage has two fixed points, one posterior, the other lateral, and that the anterior horn is more or less insecure, contributes in a measure to its liability to injury.

The semilunar cartilages move with the tibia in flexion and to a slight extent with the femur in rotation of the knee. That this movement occurs at the end of extension and in extreme flexion is an important fact in connection with the adjustment of a displaced cartilage and will be referred to later. Surls and Osgood give a splendid explanation of the movements of the semilunar cartilages. The semilunar cartilages are arranged so that they slide centrally when the joint is flexed and peripherally when it is extended so that the articulating surfaces are kept in contact at all times and a stable joint is maintained. All four extremities of these cartilages are attached firmly near the middle line of the joint. The portions between these extremities are attached to the joint capsule. Thus there is a constant pull inward on the part of the attached extremities and an outward pull by the intervening capsule. But the pull inward is the stronger and so the cartilages are held in apposition with the femoral articular surfaces. When the quadriceps contract the joint extends and at the same time the capsule is drawn tense. The capsule transmits this pull to the semilunar cartilages and draws them out of harm as the joint is extended.

The external lateral ligament is a thin fibrous band stretching from the outer surface of the external condyle of the femur immediately above the popliteal groove, splitting the biceps tendon to become inserted into the head of the fibula. It is separated from the external semilunar cartilage by the popliteus muscle which passes between it

and the cartilage from in front backward. This muscle adds considerable support to the external lateral ligament. The tendon of the popliteus muscle is surrounded by a synovial sheath and in its course sweeps past the outer surface of the external semilunar cartilage just behind its center, producing a well defined groove in the cartilage. At this point the cartilage is therefore covered by synovial membrane. This is the only portion of either cartilage that has this arrangement (Fisher).

At this point so called ganglionic cysts of the semilunar cartilage develop. Phemister described such cysts and reported 2 cases. He cites Olleren shaw who found that an endothelial lining was present in some of the cyst cavities and concludes that these cysts might arise from misplaced endothelial elements that form the joint lining.

Figure 1 shows the external lateral ligament and its relations to the popliteus muscle as it passes behind it. The point of contact is the location for so called ganglionic cysts.

The internal lateral ligament is a wide fan shaped fibrous band extending from the external condyle of the femur to the outer tuberosity of the tibia. It consists of a long anterior and a short posterior portion. The broad posterior portion is distinctly fixed to the internal semilunar cartilage. This fixation is a definite disadvantage since in a sudden twisting of the joint the cartilage cannot get out of the way of the articulation and becomes jammed and torn. The internal semilunar cartilage is therefore more commonly injured than is the external, the percentage being about 12 to 1. Sir Robert Jones gives the percentage as 7 to 1. A strain upon the internal lateral ligament is much more severe when it is associated with a twisting movement of the joint.

In order to bring about lateral movement of the knee joint we found it necessary in our experiments to sever not only the internal lateral ligament but also the crucial ligaments.

Figure 2 shows the relation of the internal lateral ligament to the internal semilunar cartilage. Note the portion that is free and retracted by the instrument. The illustration also shows the transverse ligament which binds the 2 cornua of the semilunar cartilages. The fixation of the anterior cornu of the external semilunar to the tibial articulation is quite firm.

The crucial ligaments are situated in the center of the articulation and have a very important function. The anterior crucial ligament prevents the tibia from slipping forward upon the femur while the posterior crucial ligament prevents the tibia from sliding backward upon the femur. The



crucial ligaments assist the lateral ligament in maintaining stability of the joint when it is in the extended position. When an individual has received an injury to the knee joint and the examiner is able to displace the tibia forward or backward upon the femur the knee being in the extended position the finding suggests a rupture of the crucial ligaments.

C E J F f m l t d th M h l R e  
H p t l v n h a g t l l l t of b h h o a d  
k B th l e d m th d t h p e u s f l y  
duced b t h k not Th e w a s u b l t  
f t h t b b k w d p t h f m o l c d y l s i o p  
p a t t t m p d d a t h o t m y p f e d  
Th p t n r u l l g m t w l t n d d d t p r m t  
e d t f t h t b w h l t h n t r u c a l l g m t  
w r y h e a d l t h i t l a y t h c t f  
t h t l t l k t d s b d Th p t n  
r u l l m t t t p m t t g t h e t b a t m  
f r w d h t t c l w d d d a b t  
h l f h e c t d t e b g h t t h  
d h k h w p l c e d t o

This is demonstrated the inability of sliding the tibia forward on the femur because of the short posterior crucial and the retention of the tibia in its normal relation to the articular surface of the femur by shortening the anterior crucial ligament. It must be noted however that when luxation of the tibia backward on the femur occurs and remains so for a period of time the posterior capsule contracts making induction impossible. This also takes place when the knee remains in flexion in contraction for a long time and extension becomes limited.

C E S H f m l a b o t o y f w b p l t  
t h h p t l v n h t h t r y t h t h e w a t  
m l l c d t d t a d j r v t h l f t k  
j n t S h t t d t h t t t c h d k e t k  
g b l y w h a t h p t t t w t h  
g t h O m t t h k j t t f d  
w l l d e r y p f l t h w c o d b l f l d  
p t t h d b l l t l m b l t y l t h  
t b l d e a l y b d p l d f r w d t h f m A  
r t g g m l d a f c t f t l e t l a  
d a f t f t h t b t d n g t h g h l t b l p A  
r u p t f t t a l l t l l g m t w o n f i r m d

The synovial membrane of the joint is an endothelial serous lining which surrounds all of the structures of the joint adapting itself to prominences and depressions. The joint is divided into two main compartments, the small posterior and the larger anterior. The synovial membrane extends for about 1 inch above the superior border of the patella. The synovial sac is filled with an inflammatory exudate all of the normal superficial outlines of the joint are obliterated. This is especially true of the suprapatellar surface

as well as the lateral surfaces of the joint above the patella.

In the infrapatellar space a fold or pad can be seen stretching across the joint and filling the space between tibial and femoral articulation. This fat pad is triangular in outline with the base directed upward and forward its apex is directed to the center of the joint and it is held in position by a well defined ligament known as the ligamentum mucosum. This extends from the apex upward and backward to the intercondylar notch in front of and blending with the anterior crucial ligament. Laterally the pad blends with the capsule and in addition is supported or suspended by fibro elastic bands called the alar ligaments. These bands are found on its lateral peripheral borders. They extend upward and adapt themselves to the outer and under borders of the patella blending with the aponeurosis of the quadriceps extensor tendon. The outer alar ligament is very indistinct and often missing and although frequently it can be definitely made out on the outer upper peripheral border of the patella its lower extremity becomes indistinct and blends with the pad fat.

The inner alar ligament is constantly present and often forms a double fold especially in males and in well developed knee joints but in atrophic knees it participates in the atrophy of the other structures. The inner alar ligament as a rule is wider than the external and can be traced through the fat pad sending fibers which blend with it and descend to become incorporated or inscribed with the coronary and transverse ligament into the anterior cornu of the internal semilunar cartilage. When traction is produced upon the internal alar ligament the pad can be elevated and the cornu of the semilunar cartilage can in turn be displaced from its position.

Figure 3 shows the infrapatellar fat pad. The band of fibrous tissue which holds the pad to the intercondylar notch should be noted. This is the already mentioned ligamentum mucosum. The illustration also shows the folds which extend from the pad to the outer borders of the patella. These are the alar ligaments. The inner fold is very distinct and in this case is double. The fibrous band from the internal alar ligament extend downward to become incorporated with the coronary ligament and attached to the anterior cornu of the internal semilunar cartilage.

I hold the opinion of Pozet that the internal alar ligament plays a definite role in the production of displacements and rupture of the internal semilunar cartilage. When the knee joint is opened so that the internal cartilage becomes visible and motion of the joint is carried out either

in flexion or extension the cartilage cannot be misplaced from its position. However when forcible traction is exercised upon the patella the anterior cornu of the internal cartilage can be brought forward and away from its tibial position.

We can therefore visualize the position of the knee joint which favors injury to this cartilage namely slight flexion of the knee abduction of the foot and inward rotation of the femur. Should an emergency require a sudden rectification of the joint to its normal position the following events should occur sudden contraction of the quadriceps tendon which pulls the patella with a violent jerk. The anterior cornu of the internal cartilage would then be pulled away from the region of safety by means of the internal alar ligament. In addition the knee in trying to assume the erect position would have to pass through a rotary or as it is often referred to a screw home movement accompanied by sudden extension. If the cartilage does not get out of the way of the articulation it becomes pinched and torn. Pozet has traced distinct bundles from the fibrous folds already described to the anterior ends of the semilunar cartilages and believes that they serve to pull the semilunar cartilage forward and upward with the contraction of the quadriceps. Tenny could not trace such bundles but found these folds spreading out generally into the fibrous framework of the infrapatellar pad. He believes that their function is to pull this pad forward and upward out of harm's way during extension. This statement may be correct but it does not detract from the idea that is here presented namely the effect of the alar ligament upon the internal semilunar cartilage. Tenny asserts that these fibrous bands do not appear in joints hardened in formalin. It must however be remembered that Tenny did his work on cadavers so that these delicate structures may have become distorted. Hoffa states that the lower part of the fat pad joins the meniscus and is also connected to the periosteum of the front part of the tibia. The connection to the periosteum alludes to the coronary ligament.

The infrapatellar fat pad gives off numerous small tail like padules or fringes which are intended as wipers of the articulating surfaces—so called lubricants. When by inflammatory hyperplasia these tail like padules become elongated the alar ligaments cannot pull the fat pad up out of the crushing grinding articulation and thus they often become pinched and cause the characteristic symptoms of pain and locking. It must be remembered that derangements of the semilunar cartilages may be associated with other pathology. One therefore cannot emphasize too

strongly the importance of a complete exploration of the knee when the clinical history and physical findings are not clearly definite. In several of our cases of ruptured semilunar cartilage a small portion of the synovial membrane was removed. This tissue in every case showed a chronic inflammatory change. It must therefore be borne in mind that repeated locking of the joint is not only associated with a mechanical disturbance which disappears with the reduction of the cartilage but often results in a chronic synovial inflammatory change which may persist even when the cartilage is removed.

CASE 3. A male patient 55 years of age came to the hospital stating that about 3 years before he had stumbled and sprained his knee joint. He felt quite sure that the joint locked at that time. He has had numerous lockings since then. A roentgenogram was taken of the knee and it disclosed numerous osteocartilaginous bodies. The joint was operated on. The anterior portion of the internal semilunar cartilage was practically gone but there was a chronic synovitis with numerous fibrous bands stretching across the joint and a number of osteocartilaginous bodies.

#### MECHANISM OF RUPTURE OF THE INTERNAL LATERAL LIGAMENT AND RUPTURE OF THE SEMILUNAR CARTILAGE

The knee is a modified hinge joint with only a slight degree of sliding and rotation which takes place only in the final act of extension. The most insecure position of the joint is midway between flexion and extension and is referred to by Morrison as the danger zone. When the foot is firmly fixed upon the ground the knee being slightly flexed a sudden rotation of the femur inward with an attempted extension of the knee may cause a rupture of the internal cartilage. This can best be illustrated by citing some illustrative cases.

CASE 4. A dancer during a performance when he was to catch his partner as she descended from mid air suddenly felt that his right foot was glued to the floor as though he had stepped on some gum. He could not take the sliding step to break the impact of the heavy weight. His knee bent under him and he experienced a sharp stabbing pain. The knee joint became markedly swollen and was locked in a flexed position. An X ray suggested a torn internal lateral ligament and a displacement of the cartilage. Reduction was accomplished by repositioning.

CASE 5. A painter standing upon an insecure ladder swayed backward while his foot was caught in a rung. In trying to regain his equilibrium he twisted his left knee joint and experienced a severe pain on the inner side of the knee. Effusion followed the knee became locked and the locking occurred on several occasions. The X ray report was negative. When the knee joint was opened the cartilage was found loosened and torn at its fibrocartilaginous junction.

CASE 6. A girl aged 23 years stated that while she was riding in a crowded car and hanging on to a strap the car came to a sudden stop and her body swayed forward while

h ght foot m ed f mly fi d t the floo She e  
 p n c d p th id fth htk e j t Sh  
 w k d m b t th p h k o t d Wh n h  
 c m fo v m t th w om ff h r kne  
 a m tat t t d p n th i d f  
 th k l l th p t l l Th t r n t m l u til g  
 a fo d t t h d  
 C e 7 Th p t t p t d h m l f t M h l Re  
 H p tal w t h f l l g t r y S l d y p i  
 ly wh l l l g g f m g d th o g t t  
 o d l l d t h twi ted h htk kn d f l t a  
 udd p th d f th kn c g  
 th k t g w f m l h I f t p p d k  
 a d l m p d h m Wh th k w am ed t  
 fo d t l l k i m fl Tl w d t t  
 l m t t t t d m p d c t d t th  
 d i th k m m d t l v b l d f t f th  
 pat ll v m t l d h g n th  
 j unt dad k f l pl d nd t t l g  
 m d d n m l t p t Th t l h t  
 t t l l t l j t

In addition to the anatomical factors contributing to derangements of the semilunar cartilage certain physiological reasons may perhaps explain their formation. Thus the normal rotation of the body in right handed individuals is toward the left. The body pivots upon the left knee in the act of rotation. The foot is arrested by the ground while the femur rotates inward upon the tibia. This is illustrated in the act of twirling golfing and shovelling and may account for the fact that the contraction occurs more commonly in the right knee joint.

#### DIAGNOSIS

The diagnosis of lateral ligament rupture and of fracture and displacement of the semilunar cartilages depend almost entirely upon the clinical history. These accidents occur as a rule in young active adults and more frequently in men than in women. The occurrence of events in the production of the accident must be carefully investigated. A twist and a sudden attempt at extension of the knee is the characteristic method of production of these derangements.

Because roentgenograms do not disclose derangements of the soft tissues attempts have been made to introduce gaseous substances into the joint for the purpose of bringing out the soft tissue structure. Kilberg reported a series of cases in which the knee were injected with oxygen. We have inflated the knee joint with carbon dioxide for the same purpose. As it is an end product of metabolism we felt that its effect upon the tissues could not be as irritating as oxygen or nitrogen and also that its absorption would be more rapid. Fifty knees were inflated and in each instance the practice was of great aid. When the clinical history is clear and one is certain about the finding, inflation should not be employed

but when one is in doubt as to the pathology in flation is of great help.

*Technique of inflation.* The knee is prepared as for an arthrotomy. The knee is roentgenographed in the anterior posterior and lateral position. It is then flexed to an angle of about 90 degrees and a needle inserted on the inner side below the patella. The carbon dioxide is introduced until a soft crepitus can be felt over the joint. About 30 to 40 cubic centimeters of gas is sufficient. One must be sure that the needle enters the joint before the gas is permitted to flow otherwise the gas enters the soft perarticular tissues. There is a momentary sensation of distention of the joint but no extreme pain nor discomfort. Most patients upon whom inflation of the knee was performed were from the out patient department and were permitted to go home soon after the inflation.

The spaces to be studied are the suprapatellar pouch the infrapatellar space and the posterior compartment. The suprapatellar pouch assumes the appearance of an inverted gall bladder. The infrapatellar space is almost triangular in outline while the posterior space is crescentic. In a normal knee joint all the spaces are clear and well defined (Fig 5). Changes in the infrapatellar space are indicative of hypertrophic villus synovitis chronic synovitis changes in the pad of fat and displacements and tears of the semilunar cartilages (Fig 6).

The diagnostic signs and symptoms of a torn cartilage in order of their importance are pain locking limitation to full extension and effusion.

As a result of a mild torsion producing a tear and displacement of the internal semilunar cartilage the knee becomes *locked* this locking is accompanied by a sickening pain which persists for some time and extension of the joint is more or less difficult. The pain as a rule is referred to the inner side of the knee immediately below and to the side of the patella. When numerous lockings occur the pain is intense. When reposition is accomplished the pain at once subsides and the knee assumes a normal extension.

*Limitation to full extension* is the next important symptom after pain. Normally the knee joint can be extended to an angle approximately 180 degrees. In derangements due to semilunar cartilage displacement the knee is bent and it is difficult and painful to straighten it out. When reposition of the cartilage is accomplished the knee can be straightened to almost normal extension.

*Pain* is a constant symptom and is described as sharp lancinating stabbing or boring in char-

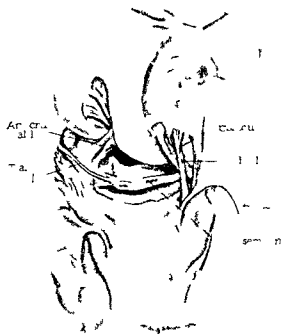


FIG. 1. External lateral ligament and relation to popliteus muscle.

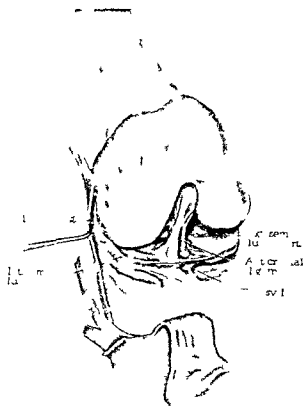


FIG. 2. Relation of internal lateral ligament to internal femoral condyle.

acter. The pain is referred to the inner side of the knee below and to the inner side of the patella. The pain is often severe enough to keep the patient awake and is most intense when motion of the joint is attempted. Tenderness on pressure is marked at the site of the cartilage and over the internal lateral ligament. Pain is also experienced when an attempt is made to stretch or mobilize the knee joint. When the cartilage is replaced the acute pain subsides but there may remain a dull ache for a short time and pain may be experienced when the joint is moved.

*Effusion* is variable in quantity. As a rule there is very little fluid in the joint but the knee may be increased in size. When the joint is locked in flexion and is permitted to remain in that condition for some time the effusion is increased in amount. Repeated lockings may not cause further effusion.

Aspiration of the joint is never indicated. The effusion is a result of irritations and trauma and is an exudative process. When effusion is present inflation of the joint for diagnostic purposes should be postponed until it has cleared up.

CASE 8. A professional dancer, aged 33 years, entered the Chelsea Hospital with the following history. About 4 years ago she had slipped and twisted her knee while dancing. The knee was quite painful and she was unable to

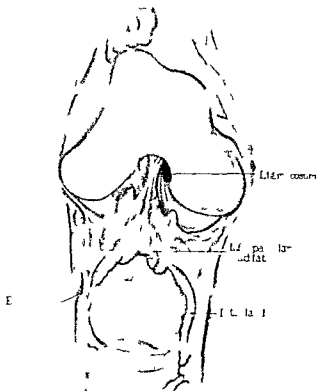


FIG. 3. The infrapatellar fat pad.



F 4

F 5

F 6

F 4 A t p t w f fl ted k j t  
I fl t f th k j t bt b d d a  
t t t th t t th fl g b th t l  
j l l v l th t l f th k j t Th  
tt hm t f th t l l t l l g m t t th t al  
m l t l pl l v bl Th t l m  
l t l att h d Th g d t d th  
p p t l l p h Th m l k  
l Sh fl t f m l k j t t y m n  
f t j l t t th fl l th p p t l l  
p h m th h p f g l l d d Th l l  
m th j l Th f p t l l p m l  
t l t l d t l p t n m p t m t f th  
k j t s m l o t l W l p t l g v

t ght t O th n d d y th k w l l d  
t t t fl H t p p l t d d th  
t t t m i l d f b t k Th l l  
b l l t l p g a d l y d p p j Sh e  
j l l t l f t d A b o t y h  
m t h l l k g n d h d f y m p  
t m m l t t h h p d f t th h t j  
Sh t l t t h h j l Th d m d  
f t j l p l t l m l t l  
Th k p d t h g h J d th  
l l t f t t l a g l v l k f f g b d v  
l h m d t h k j t l d Th k  
t t t m l t t d th p t f f  
t l l t h p t t m  
S l l k h w l g f Wh l  
t t p t l l l p p d d f l t t fl t t g  
h k l h Sh t m m b h h h  
f t t l t l k t Sh th k th t h fl d  
h fl d k Th w t m p d th  
f t l k S l h t l l p p d d th p  
w h t t t h f m l p  
O o t t t m d t t m y p f m d  
l l th Th h l t f t h j t e  
f l l y d t l h l p t d Th p p t l l  
h p m i t d d p t d g l v  
y l l p p T i f t t w l g t d  
d t h c k d Th f t p d w l k d p t p t d  
t l g l l t h l a l p t f h y t

p t th k j t th e p es d t t d  
d d t l z d h th p c f f o m t e l  
t l t l f t t t r u t F g e f  
l 6 L t l f fl t l k j t s h w  
p p t l l p h l t l d s m hat  
d m h d u z Th f p t l l a p m o o l  
l t l k p p At th t r t l r f c of  
th t b p l t th p t f th t r n a l  
t l g h d p t Th l d p l c d  
t l h h p t m e d p t A o c t d  
th th d p l d t l g h y l c h g wa  
p t th k j t Th t f th d e i  
u z f th f p t l l p d p b bly d to  
h y p t p h d p d f f t

Th m a t l m l c t l g a f th  
t k th fl typ f d p l m t Th t p t  
k d t l m n p t f th t l ap  
p d m th h l d d p l d t t h t f  
th j t Th t l m d t t t y t  
g th th the th k d l t d p t  
f th t p d Th p t t d f m t th j o t  
d l f t h h p t l t l t th d v l k g t n  
r u t h

This case illustrates the importance of carefully inspecting the interior of the joint. If a careful examination of the internal cartila had been made at the time of the first operation there would have been no recurrence of the condition. However it was thou ht at the time of the first operation that the anterior free margin had been torn off and that the remaining portion of the cartila e was in place

C a g A y g th l t m 6 y f g t t  
th t b t y l half h l at p t p l b  
k m l h l d t k n t p l l h m d n  
h l v l h t k d th g t p th q l l y  
H f l t d d p h h t k d d l d t  
t g l t th j t t t m l e t d d p t Th

knee hurt him considerably and for 10 days he limped. After that time he had occasional pain in the knee localized on the inner side of the joint below the patella. During the attacks of pain his knee locked and he could hear a click in the joint.

On examination the knee appeared normal—no swelling or effusion. It could be extended and flexed to almost the normal range. On the inner side of the knee joint the examiner's thumb being firmly held over the region of the internal capsule, a click such as one often finds over a slipping tendon could be felt. There was some tenderness. Examination was negative.

Diagnosis was made of a displaced and ruptured internal semilunar cartilage and on September 1906 the knee joint was operated on. The method employed in this case is the same as that carried out in all our cases and will be described in detail.

#### OPERATION

The extremity is shaved above and below the knee joint special care being taken to remove all hair over the knee since long hair may be responsible for infection following the operation. The knee is prepared the night before by a thorough washing—ether and alcohol and a coat of iodine. This procedure is repeated at the time of the operation. One must always bear in mind that because infections do not occur as commonly after operation as in times past one cannot become lax in the preparation of patients. I always prepare the knee joint myself in order to be absolutely sure of the asepsis. The knee is bent to an angle of 45 degrees over the foot of the table. An elliptical incision is made  $\frac{1}{2}$  inch to the inner side of the patella beginning about  $1\frac{1}{2}$  inches above and carried about  $1\frac{1}{2}$  inches below the patella. All bleeding points are ligated to prevent any possibility of hemorrhage under the skin. Very fine catgut is used and the ends cut very short. The parts are covered with wet lap sponges and a second knife used to cut the subcutaneous tissues and the fascia down to the capsule of the joint. The capsule appears like a tense loose structure. This is incised with a pair of scissors and the edges are caught as in the case of the peritoneum in abdominal section. The edges are retracted and the incision is completed above and below to expose the joint. The first visible structure is the inner condyle of the femur. Two small ribbon retractors are introduced into the joint and the joint is thoroughly inspected. The cartilage can now be easily seen resting on the articular surface of the tibia. The anterior crucial ligament appears as a firm fibrous band. The anterior cornu of the cartilage is gently grasped with a tissue forceps and inspected for pathology. In this particular instance the cartilage was long and twisted and displaced to the center of the joint. It was a typical bucket handle variety. The

cartilage was severed at its proximal portion close to the tibial attachment and pulled forward and severed from the capsule by means of a curved dissecting scissors at its posterior attachment.

The fat pad can be examined for inflammatory changes and elongations of fat trigs. In each instance we found a change in the fat pad characterized by inflammatory hyperplasia. Any oozing that takes place can be checked by a small gauze pack which is inserted into the joint and held there for a few moments. It is not advisable to compress any small bleeding points nor is it advisable to place ligatures into the joint. If ligatures are to be used they should be of fine catgut and the ends cut very short. The capsule is now sutured with a fine catgut stitch, the subcutaneous tissue with No. 1 chromic catgut. The skin is closed with a running silk suture. No drains should ever be inserted into the knee. The limb is placed in extension in a posterior molded plaster splint. Passive exercises are to be employed as soon as the patient can bear them. On the tenth day the patient is encouraged to use the limb and permitted to step with the aid of crutches.

As one gains experience in this type of surgery he approaches the knee joint without apprehension. The employment of the Lane technique cannot be emphasized too strongly in connection with knee joint surgery and it must always be remembered that an infection following the removal of a semilunar cartilage can leave the patient with a stiff knee. When the diagnosis is uncertain a median arthrotomy should be performed. The knee joint is approached through a split patella. In this way the entire knee joint may be inspected.

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TUBERCULOMA OF THE TRACHEA<sup>1</sup>

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**T**UBERCULOSIS of the trachea secondary to infection in the lungs is rarely diagnosed except at postmortem examinations when small superficial recently formed lenticular ulcers involving the posterior wall of the trachea are found. These ulcers are a terminal complication of pulmonary or generalized tuberculosis. Statistics vary as to the frequency of their occurrence. Heinze reports an incidence of 1.5 per cent. Ojhuks reports infection in the trachea and bronchi in 10 per cent of all cases of active tuberculosis. Gidionsen and Mackenzie and Schmiegelsky report cases of primary tuberculosis of the trachea. Occasionally tuberculous bronchial lymph nodes ulcerate through the wall of the trachea.

The case herewith reported is unusual because the patient's general health was extremely good and the only symptom was inspiratory dyspnea. Observation also indicates the value of bronchoscopy when symptoms could easily have been mistaken for pulmonary fibrosis by ordinary examination.

A. W. M. J. g d 48 h t g t J t t h M  
Cl J s q Th p t t f t h l d d d

Trachea



a

Tumor



b

f m p l m o r y f e t o p b a l l y t b e l O  
m t l t d t c u s h a d d f o m  
t b l Sh h d h d c l e t f p m a d  
t p l d f y t h Sh c o m p l d c h f l y f c g h  
h h h d b g d l t t t g p p m t l y  
v b f h d m t t h e c l c l l v m  
p d d n g t h v i t e d p n g d c l r i g p  
t l y t l m m l y r s p l y t h g h  
h d t d b l y d y p l y t h l  
b m m p t n t n d t h h d b e e l t t p t m  
l l y l l t k l l t t m e t h e w l i g h t f e  
p d g h t h d b l o s t  
Th p t n t w h d s p d Sh h d f  
q t h l g m t The d l l e s b o t h  
p w t h p r s t t p t t d l Th h a e m g l b  
p t r y t h o c y t e s m b e d 4 6 5 o o o d  
l v t 8 9 Th b l l W m t t d t h  
n l y w e g t i t g r a m t t h e s t  
h d l l t l p l m r y t b e l o s v i t h b h c  
t t l t h t T b c u l o b c l l w p s t i n  
t h p t m A d g o s f b l t l p l m y t b  
l m d d t h p t t f r d t t m  
f t t m t Sh p t t h g t p a t f t h f l l w  
v t m C l d d m d t m k  
p l d r y g g p o d w g h t  
I D m b 9 6 g p t r y d y p e  
l l p d g d l l y d h d i t m m l s t y n  
M h 9 7 U p t t h t m f t h e c d d m u s t  
t h l J e 9 7 t h h a d b n p a c c l l y n  
h g t h e d e g e f d y p e The w m a k e d  
p t r y d y p e a C y o f t h l p d f i g t p  
b g h t b y h e t n w l k g a c t h  
fl Th h d l a l o o f 5 p d w g h t Th  
p l m y d t p p d t b q e s c t Th w s  
f d t h t g a m f t h c h t w t  
p t d h w g h l d l e s F m t f t h  
l r y g t



I k B h p w f t m f t h b T Ph t m g p h f t r m o d f m t h l  
S h m t d h g t t f t c h l t m t m r (X 75)  
S b m d f p b l A 8 9 7

At broncho-copic examination the left wall of the trachea was found to be invaded by a large mass which reduced the lumen to about one-fourth its normal size. The mass began about 5 centimeters below the larynx and extended almost to the tracheal bifurcation. It was difficult however to determine with accuracy the lower limits of the process. The tumor was granular and firm and moderate bleeding followed the removal of a section for micro-copic examination.

Grossly the lesion resembled a malignant tumor of the trachea but the extent of involvement was greater than had been previously noted in tracheal carcinoma (Fig. 1). The micro-copic examination of the tissue disclosed its tuberculous nature (Fig. 2).

Following broncho-copic examination the patient was able to breathe with greater comfort because on introduction of the broncho-cop to the bifurcation of the trachea superficial ulcerating tissue was removed and the lumen of the trachea was thereby enlarged. A course of treatment by

deep roentgen rays was given and the patient instructed to continue with the usual anti-tuberculosis regimen.

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## FASCIAL GRAFT FOR DISLOCATION OF ACROMIOCLAVICULAR JOINT

By STERLING BUNNELL, M.D., SAN FRANCISCO, CALIFORNIA

In complete upward dislocation of the outer end of the clavicle not only the acromioclavicular ligaments but also the conoid and trapezoid ligaments that should hold the clavicle down to the coracoid process are ruptured. This allows the outer end of the clavicle to ride upward in the shoulder when the patient lifts, produces considerable deformity, causes weakness in the lifting power of the arm and difficulty in some shoulder movements.

At operation not only should the acromion process and the clavicle be fastened together but the clavicle should also be held down to the coracoid process. Ankylosis of the joint will not permit movement. Wire if used in tying the parts together will wear and break as in any

movable part. Tying of the clavicle to the coracoid process with fish line has been recommended also but such a foreign body will wear out in a short time.

Fascia is the ideal material as it is a natural binding agent, it hypertrophies under conditions of normal tension, allows normal motion in joint and lives as long as patient. A quick, easy, efficient method of using fascia has been devised.

Through an L shaped incision with its apex an inch anterolateral to the joint the upper surfaces of the acromion and clavicle are exposed and also the coracoid process at its ligaments. Three holes 5 millimeters in diameter are drilled. The first hole penetrates the tip of the acromion slightly in front of the center of the joint, the



FIG. 1



FIG. 2



FIG. 3

FIG. 1. Showing the anatomy of the conoid and trapezoid ligaments, the position of the 3 holes in the bone and the fascial graft (indicated by rubber tube) in place but not yet drawn up.

FIG. 2. Showing fascial graft indicated by rubber tube in place and tied as seen from the front.

FIG. 3. Posterior view of the specimen shown in Figure 1.





Fig 4 15 Sp (11ft) 1 f o f am p m  
h g t f m t f j t t l



Fig 5 15 Sp (11ft) 1 f o f am p m  
h g t f m t f j t t l

second penetrates the outer end of the clavicle slightly behind the center of the joint and the third penetrates the clavicle at the outer end of the trapezoid ligament.

The upper surfaces of the bones are then denuded of periosteum in a line with the holes and at the posterior border of the clavicle so that bony contact with the fascial graft will be obtained.

A strong piece of catgut on a curved needle is then threaded down hole 1 up hole 2 then passed back of the clavicle and with a Deschamp carrier is passed around under the coracoid process down

its inner side up its outer side and finally up through hole 3.

A strip of fascia lata 10 inches long and 1 centimeter wide is then taken. One end is cut in a long taper caught in a slip knot in the middle of the piece of catgut and drawn through each hole in turn along the course of the catgut.

A piece of No 3 chromic catgut is passed through holes 1 and 2 tied tightly in order to hold the joint to ether and prevent strain on the fascial graft until the latter has grown to itself and to the bone.

The two ends of the fascia are then by fastening a hemostat to each drawn up tightly crossed over toward each other and held there while they are whipped to ether with a running stitch of No 3 Turner's patent ligature silk previously dipped in bichloride solution. The third ply of fascia is also caught in the stitch. The end pointing inward is cut off and the other end is laid across the joint to reinforce the capsule further and is held there by a stay suture. The wound is closed and the arm placed in a sling for weeks.

#### ADVANTAGES

The one strip of strong fascia reproduces anatomically the conoid and trapezoid ligaments as the two fascial strips correspond to the two borders of these ligaments. It also reconstructs the superior and inferior ligaments of the acromioclavicular joint and reinforces the superior ligament with an extra plication. The fascial plications fuse to each other and grow to the bones by intimate bony contact.

Practically the method gives a perfect result as shown in Figure 6. Although the patient is lifting a heavy anvil no difference can be detected in the contour of the joints on the two sides.

# LIGATURE OF THE ANGULAR VEIN AS A PREVENTIVE MEASURE IN FACIAL CARBUNCLE

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**C**ARBUNCLE of the face has a sinister reputation and the upper lip is the most common site of this dreaded lesion. A complication which quite frequently heralds the oncoming of a fatal pyæmia is thrombophlebitis of the cavernous sinus.

In a series of 15 consecutive cases of thrombophlebitis of the cavernous sinus I found that 4 were due to a furuncle or carbuncle of the upper lip and that 3 more originated in an infected gnath bite of the nose. Thus in nearly half the cases of the series referred to thrombophlebitis of the cavernous sinus had its origin in a comparatively simple lesion in a circumscribed area. While reference to Eagleston's monumental monograph on cavernous sinus thrombophlebitis convinces me that this percentage is abnormally high, it is clear that infections of the upper lip and the skin of the nose are the cause of a formidable proportion of the cases of thrombophlebitis of the cavernous sinus met with in general surgical practice.

From an anatomical consideration infection may pass from the upper lip and the nasal integument to the cavernous sinus by one of the two venous paths. That the more circuitous route through the pterygoid plexus is not often taken is shown by a study of necropsies of this condition in the records of the London Hospital Pathological Institute.<sup>1</sup> In 4 cases the path of the pyæmia could be traced satisfactorily along the angular vein.

It is therefore reasonable to assume that the angular vein forming as it does a communicating link between the venous radicles of the upper lip and the ophthalmic plexus constitutes a main channel by which infection passes into the venous system.

To forestall the spread of infection by this route ligation of the angular veins must be a sound proposition, but the risk of the inhalation of a general anæsthetic in a febrile patient whose buccal cavity is swarming with virulent organisms has deterred surgical enterprise in this direction.

Ligature of the angular veins under local anæsthesia is a measure which is entirely free from

danger and one which can only do good. If necessary ligature may be done on both angular veins.

It is desirable to have some guide as to the most opportune moment for this intervention, for it is quite obvious that the resistance of the patient is sometimes sufficient to keep the infection within bounds. On the other hand the necessity for timely interference must always be before us. On the whole it is better to err on the side of activity.

A sign which foretells impending danger is spreading œdema from the lip to the inner canthus, and this is usually found in the presence of suffusion of the eyelids. As far as my own observations have gone the premonition is invariably unilateral. If in addition to this sign there is considerable elevation of temperature the call for action is imperative.



Fig. 1. Ligature of the angular vein.



Fig. 1. C. 1. 1. f. th. pp. 1. p. A. T. 1. h. ft. 1. k. t. f. g. l. 1. B. S. m. e. k. l. t. C. Sam.

#### TECHNIQUE

If there is any suggestion of delirium it is advisable to administer a hypnotic 20 minutes before operation. Castor oil should be introduced into the eye and a damp gauze covering applied over the lid to prevent iodine running into the conjunctival sac. The lip is covered with gauze wrung out in mercuric chloride solution. Dry gauze becomes easily displaced. The angle made by the junction of the nose with the cheek is the surface marking for the vein. After novocain has been infiltrated an incision is made commencing a little below the inner canthus and passing downward and a very slightly outward for about 1 inch.

There is always a lot of troublesome oozing which can be quelled by packing with gauze soaked in adrenalin. After more novocain has been injected dissection in the wound will reveal the levator labii superioris alque nasi. The fibers of the muscle are teased apart and the alar vein will be found either in or beneath this muscle. It is divided between ligature. Skin sutures and a colloid dressing complete the operation.

C. F. A. g. w. m. q. f. g. h. d. b. l.  
h. pp. 1. f. S. l. h. 1. h. d. t. f. d. y. s. It. b. n.  
p. m. p. l. h. l. h. h. d. q. d. The. p. t. t. h. d. c.  
l. 1. l. d. l. m. n. d. t. m. p. t. f. 4. d. e. Th.  
ht. y. w. m. p. l. t. l. y. l. d. b. y. ff. f. th. l. d.



1. f. t. C. h. 1. f. th. pp. 1. p. Th. m. b. o. f. th.

Γ. 4. Th. mb. f. th. C. b. l.  
f. th. pp. 1. p. Th. ll. t. t. f. m. th.  
a. th. s. P. j. I. S. g. Cl. I. S. g. y.

Under general anaesthesia the right angular vein was ligatured. The carbuncle was incised through the red margin of the lip. Local applications of gauze soaked in hot magnesium sulphate solution were applied. After a slight improvement for 48 hours on the fifth day the patient succumbed to a terminal pneumonia complicating general septicemia.

CASE 2. A girl aged 16 complained of a large carbuncle which had begun 9 days previously as a pimple on the middle of the upper lip and which had developed into a carbuncle of both upper and lower lip. It had become much worse 48 hours before admission. Examination showed an oedema spreading toward the right eye with great suffusion of the eyelid. Her temperature was 103 to 104 degrees as ocured with mild delirium.

Ligature of the right angular vein was made and intra-venous mercurochrome was administered followed by local treatment of the carbuncle with hot magnesium sulphate fomentations. Rapid improvement resulted and the patient was discharged 11 days later.

CASE 3. A man 60 years of age was admitted with a carbuncle of the upper lip of 3 days history. His temperature was 103 degrees. There was oedema spread up to the right eye. The angular vein was ligatured and whole blood was injected around the periphery of the carbuncle. Hot gauze soaked in hot magnesium sulphate solution was applied locally. A blood culture grew a staphylococcus. Intra-venous mercurochrome was administered on the second day. Seventeen days later the patient had recovered sufficiently to return home.

Case 1 occurred 4 years ago. I now believe a general anaesthetic is absolutely contra-indicated in these cases. As regards the local treatment of a carbuncle I have given up incision and simply

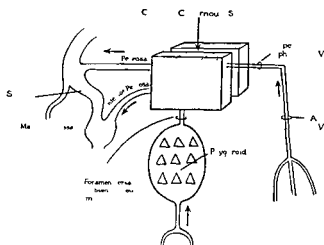


Fig. 1. The venous system and its connections (diagrammatic) taken from the author's article in the *Clinical Journal*.

inject the patient's own blood into the tissues around the carbuncle and apply hot moist dressings. This combined with general treatment has given satisfactory results in carbuncles in all situations.

#### PITUITARY

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L. AGLTON, WFLI, I. Cavernous Sinus Thrombo-  
phlebitis. New York 926

# A SHORTER TECHNIQUE FOR THE COLICA OPERATION IN CANCER OF THE RECTUM<sup>1</sup>

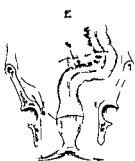
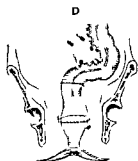
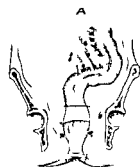
B. DUDLEY SMITH, M.D., F.A.C.S., F.R.C.S., F.R.C.P.

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FOR many years the principles of operative procedure in cancer have been definitely standardized but many surgeons seem to disregard the fundamental principles in operating for cancer of the rectum. Unless the peritoneum removes the lymphatics in the three zones it spread to well described and illustrated by W. E. Miles (1) in the *British Medical Journal* it is not a complete operation and the percentage

of 5 year cures will not be as high as it should be. This removal can be done only by a radical abdominal perineal operation (1, 2, 3).

The one stage abdominal perineal operation of Miles unfortunately carries with it a primary operative mortality of 5 per cent or more even in his skillful hands. This high immediate operative mortality lends strength to the argument for less radical procedures.



I g A D h m h g th t t d t f  
K t p t Th t m m l y d t d t f  
t t t t t t t t t t t t t t t t t t  
th p a d i t l d d d f p a d  
l f t  
B D g m h o th f i t p th l t f th  
d l p t Th p n a l h h e f d  
f t e d l y m d th t h b e f d  
ul b l t e c u  
C D g m h g th t f th p t f l d  
f th t p th l t of th d l p t  
l d d t th p n l k d th h t f t  
l f th l t r m l l th l p t f th  
p e l m o c l l d d th p t w h h  
e e d c t d t th t f d t l  
ul r a b l  
R d b f h A m

D D h m l g th l m t d h t f th m l  
p t t d h m l h t t t t t t t t  
f D h m h h m h f th l b l t  
f th t h f p d l f t b h d t th b l m  
l p e t l t h n th p m l d t h l  
b h t d t t h n th l b l t f th  
l f t  
I D h m h g th f l t g th e l t f th  
d l p t Wh th ul b l t th  
l t l d d d f p d m y b m d  
m p l t l b y p t d t f m th p m  
l m t g t p t f th t d th p p d t  
m t f h Th t h h p p d t  
th l l th l m p t b m l l  
b y t l d l b l m p l m thod (I m C f f  
mod h t f M l l t t )  
y P h d l p h M y 9 7

Fortunately however Pobert C Coffey has devised an abdominoperineal operation which is done in two stages has in his hands an operative mortality of about 5 per cent. No operation can be more complete and thorough. Coffey in 1942 presented a clear and well illustrated description of his operation which includes the following steps:

1 Long right rectus incision

Ligation of the superior hemorrhoidal artery and vein

3 Mobilization of the sigmoid and rectum

4 Clamping and cutting of sigmoid drawing proximal segment through stab wound in left rectus for colostomy

5 Pushing rectal tube up through sigmoid to clamp on distal segment placing purse string suture around the gut below clamp removing clamp end inverted fixing end of rectal tube to inverted end of gut trimming mesenteric fat well down to the bottom of the pelvis inverting sigmoid and rectum and drawing them out through the anus

6 Closure of raw surfaces and formation in the male of an extra abdominal peritoneal tube for drainage through the lower angle of the abdominal incision. In the female the peritoneum and abdomen are closed in the usual way and drainage is secured through a hole in the posterior vaginal fornix

In cases in which the cancer has caused sufficient obstruction to prevent inversion of the sigmoid and rectum Coffey double clamps the rectum either above or below the cancer cuts between the clamps with the cautery and removes the sigmoid and the portion of the rectum above the lower clamp leaving the clamp on the stump of the rectum the handles protruding in the male from the lower angle of the abdominal incision and in the female from the vulva. This is a long operation Coffey says. There is much sewing to be done in this operation which requires a great deal of time. In short the radical operation for cancer of the rectum is one of the largest in surgery.

It has been my purpose to shorten the operation as much as may be without abridging its thoroughness. We have not found that better results follow when the sigmoid is inverted than when the gut is clamped off and the tissues above removed. Moreover if lymphatic extension is present in the mesentery or the retrorectal fat the trimming off of the fat well down into the pelvis is not without danger of transplanting cancer cells. Accordingly the clamp without

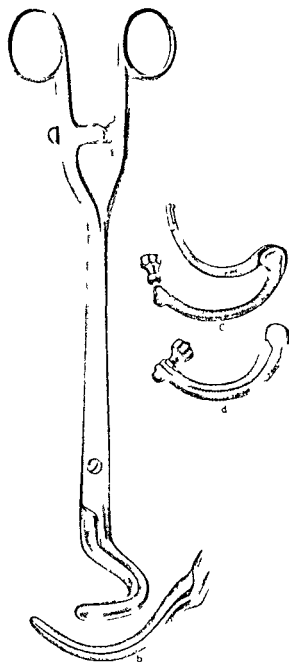


Fig 2. Author's clamps. *a* Long clamp with jaws almost at right angles to the handles. *b* Shows the curve of the jaws of clamp *a* corresponding to the curve of clamp *c* *d* Bite 3 inches. *e* *n* *c* Clamp without handles open. *d* Clamp closed. Bite 2 inches long.

handles (Fig. *c* *d*) was devised. The technique of Coffey as already outlined is followed up to and including the fourth step. The fifth step is eliminated and in its stead the clamp is placed around the rectum either above or below the growth depending upon its location closed tightly by means of a long handled strong jawed forceps and the clamp securely fastened by the thumb screw. The rectum is clamped just above with a right angled forceps with curved jaws

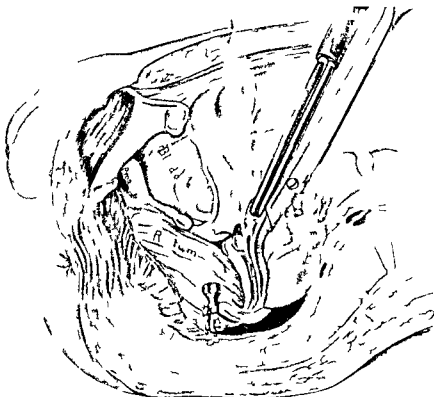


Fig. 3. The mobilized rectum and sigmoid removed and the stump of the rectum where it is held by the clamp is thoroughly sterilized with the cautery. A pack of gauze is placed over the rectal stump and around the clamp completely covering it so as to protect the adjacent tissues from pressure. Over this is placed a piece of rubber dam and the peritoneum sutured over it (Fig. 4). The abdomen is closed in the usual manner leaving the clamp in the pelvis until the second stage of the operation is performed 10 days later.

corresponding to the curve of the other clamp (Fig. 3). The gut is then severed with the cautery between the clamps (Fig. 3) the mobilized rectum and sigmoid removed and the stump of the rectum where it is held by the clamp is thoroughly sterilized with the cautery. A pack of gauze is placed over the rectal stump and around the clamp completely covering it so as to protect the adjacent tissues from pressure. Over this is placed a piece of rubber dam and the peritoneum sutured over it (Fig. 4). The abdomen is closed in the usual manner leaving the clamp in the pelvis until the second stage of the operation is performed 10 days later.

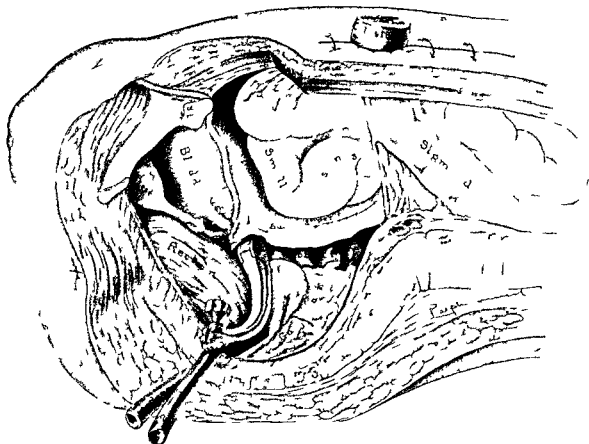
We secure drainage by making a small incision alongside the coccyx through which 2 rubber tubes are passed upward into the cavity back of the mobilized rectum (Fig. 4).

Objection may be offered to drainage through a posterior stab wound on the ground that it is uncomfortable for the patient but we believe dependent drainage to be advantageous and we

have not found that it adds to the discomfort of the patient.

This procedure saves the time required to perform the fifth step of the Coffey technique and that part of the sixth step in the male wherein the extra abdominal peritoneal tube for drainage is formed. Moreover no handles protrude from the abdominal incision nor from the vulva which is advantageous.

The second stage of the operation is a posterior resection of the stump of the rectum ischioanal fistula levators and perianal skin. The patient is placed in the prone position with head and feet lowered. Sacral analgesia is used. The incision is made over the sacrum in the midline running around the anus and including a wide area of the perianal skin. The coccyx is removed. The dissection is made wide of the rectum. The levators are cut as far distal to the rectum as possible and much of the dissection can easily be made with the fingers following the line of cleavage caused by cutting off the blood supply from



F 4 The segment of sigmoid and rectum from the colostomy to the clamp has been removed the gauze pack placed in the pelvis and over it a piece of rubber dam the peritoneum and abdominal incisions on closed two rubber drainage tubes inserted into the cavity back of the mobilized rectum through an incision on the coccyx The gauze pack should be placed completely around the clamp to protect adjacent tissues from any possible pressure

above at the first operation There is very little bleeding and that only from the skin and anal muscles The clamp gauze pack and rubber dam are removed with the rectum and a surprisingly clean cavity is left The cavity is then packed and healing is brought about by granulation The patient is ambulatory after about 2 weeks

This technique is equally applicable in the male or female in non obstructing or obstructing cancers and for growths located at any point in the rectum or lower sigmoid

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- 1 MILES W E British M J 1920 11 730
- 2 COFFEY Surg Gynec & Obst 9 4 1911 723



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been quite contrary to such theories and for that reason are here set down.

It has been our aim particularly during the last few years of our operative experience with thyroid disease to eliminate drainage in every possible instance and we have closed all thyroid wounds tightly except when the superior mediastinum had been opened when a considerable pocket remained as after the removal of a large adenoma or when an oozing existed that could be controlled best by means of a small pressure gauze pack. That drainage has been but rarely employed in our hands is evidenced by the fact that in the years 195 and 196 a total of 1810 thyroid operations of all varieties were done and of those but 0 per cent were drained. These figures include the introduction of drains of any variety even the introduction of small slips of rubber dam just beneath the skin flap when oozing in this flap cannot be adequately controlled as is the case often when the flap is raised a second time in two stage removals of the gland as by two separate hemithyroidectomies. If the figures merely included those in which drains were introduced down to the remnants of thyroid itself beneath the prethyroid muscles the percentage of cases drained would be very much smaller.

With this plan of non drainage following partial thyroidectomy we have not been disturbed by undue thyroid reactions our mortality during these years has not been greatly elevated—in exophthalmic goiter 0.99 per cent in toxic adenoma 1.77 per cent—and we have been more and more convinced of the desirability of closing thyroid wounds without drainage except for definite technical reasons such as oozing dead space or openings leading into the mediastinum.

Should it be necessary to employ drainage we urge strongly against the use of stab wound drainage below the center of the incision as has been so commonly employed in the past. The scar which remains following drainage at this point is thick and is quite unnecessary. It is located so that it is very noticeable as it cannot be covered by beads.

We would also urge strongly against bringing the drain out through the center of the transverse incision for the removal of the thyroid. We employed this plan in the past and gave it up because of the fact that the scar tissue which filled in the midline drainage sinus so fixed the skin to the trachea and thyroid remnant that the median portion of the scar was often held up in a most unsatisfactory and disfiguring manner.

We have now for some time led the drain or

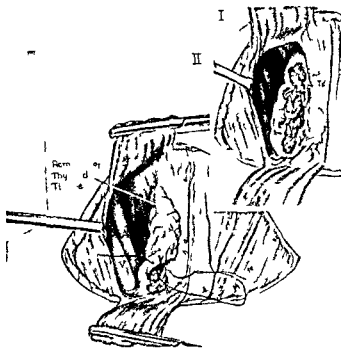


FIG. 1. I This illustration shows the removal of the thyroid lobe. II shows the method of suturing the outer cut edge of the thyroid remnant over a sutured trachea so that all of the open oozing surface of the gland is buried and the smooth posterior surface of the gland then percutaneous. This results in complete control of all oozing and practically the reconstruction of a new lobe.

drains when it is necessary to employ them out through the external angle of the wound where the skin does not become adherent to underlying structures and no disfigurement results.

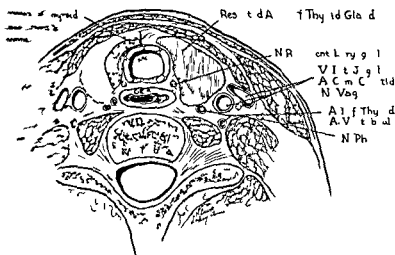
In certain cases in which the drains are to be brought out at the external angle of the wound it will be found that the sternomastoid muscles lie so far forward that the drain cannot be brought out without angulation. In these cases we have passed the drains through the bellies of that muscle by bluntly separating its fibers with scissors at the level through which the drain is to emerge.

Following non drainage after thyroidectomy we have not had accumulations beneath the prethyroid muscles requiring secondary opening and have not had difficulties with wounds breaking down. The postoperative thyroid reactions have not increased in numbers or in intensity and the operative mortality has not been high.

We have frequently had small pockets of serum accumulate directly in the wound scar 10 to 12 days after operation and occasionally sooner but have never had any difficulty in caring for them by evacuation of the serum with a probe for a few days when the patient returns to the clinic for dressings.

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tracheal tissue is describ d by us in SURGERY  
GYNECOLOGY AND OBSTETRICS so that the cut  
surface of the thyroid is held firmly against the  
trachea and the smooth uncut posterior surface  
of the thyroid remnant presents uppermost on  
the reconstructed and remaining thyroid rem  
nant

## CONCLUSIONS

Drainage follow ing thyroidectomy is necessary  
only for technical reasons—to take care of un  
controllable oozing to eliminate dead spaces in  
which blood may pool and become infected and  
to protect the open d superior mediastinum  
against infection

Thyroid reactions follow ing operations upon  
the gland are no greater when the wound are  
closed without drainage than when drained and  
in our experience are not related to this factor

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## A BLOOD-VESSEL CLIP SET FOR INTRACRANIAL WORK

By ROLAND M. KLEMMER, M.D., St. Louis, Missouri

F. m. t. D. p. t. f. S. g. r. y. f. Washington, U. S. S. h. i. l. f. M. d. d. B. H. o. p. t. l.

FROM the time of the appearance of Cushing's clip forceps holder former and scissors up until 2 years ago we have been entirely dependent upon them for controlling hæmorrhage of the cerebral vessels. Their use has been associated with varying success but unfortunately there were many instances when we met with great difficulty in handling them the clips were sometimes imperfectly formed as a result would not fit the holder properly and consequently could not be applied to the bleeding vessel successfully. A further cause of trouble we believe was the fact that wire was used, with the result that the arms of the clip crossed when the clip was pressed together. For that reason ribbon has been substituted. Furthermore the stop pin used in this clip holder as described later prevents lateral movement of the clip and also prevents the clip from slipping away from the vessel when pressure is applied to the clip at its apex.

I have worked out a set of instruments for this purpose which produces a clip uniform in size and which any assistant can make without difficulty. The new outfit complete consists of a clip cutter (Fig. 1) a clip rack (Fig. 2b) and a clip holder (Fig. 2a and b).

The clip cutter is an instrument of tooled steel which cuts a uniform clip of silver ribbon. This is accomplished by feeding the flat silver ribbon through a slot in the block of the cutter (Fig. 1a) and when the jaws of the cutter are closed the flat wire is cut and molded into clips (Fig. 1b). These clips are uniform in size and the length of

each side of the clip is identical i.e. the apex is equidistant from the base. These are placed on the rack (Fig. 2b) which has a broad corrugated base. The jaws of the clip holder are placed in the grooves of the corrugated base and the handles brought together (Fig. 2b). The holder is with drawn and the clip is in place (Fig. 2c). The clip may also be picked up without unlocking the handles by slipping jaws over rack.

The jaws of the holder are counter sunk half the thickness of the ribbon and the pin in the jaw is machined out to the thickness of the clip (Fig. 2a arrow). The clip is held in place snugly by the jaws and pin thus preventing any lateral movement. The pin in addition prevents the clip from slipping up into the clip holder. An experience that is not infrequent when holders without the stop pin are used. This important feature cannot be too strongly emphasized.<sup>1</sup>

The making of clips with this instrument is very simple and it is well to make them up before an operation. Experience has shown that frequent boiling of the clip cutter dulls the sharp

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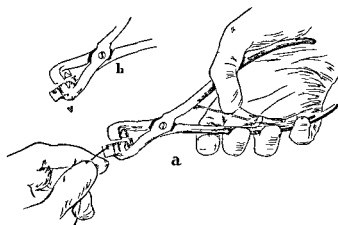


Fig. 1. Clip cutter and detail of instrument



Fig. 2. Clip rack and detail of clip forcep

edge of the tooled steel which makes the important sharp angulation of the clip. Passing the holder through saline after the application of each clip keeps the jaw clean and prevents the sticking of the clip in the groove into which it fits.

This instrument has been in use in the neurosurgical clinic of Washington University School of Medicine and Barnes Hospital for the past 2 years and was demonstrated to the members of the Society of Neurological Surgeons at their meeting in St. Louis in December 1906.

## AN OVERHEAD FRAME FOR PLASTER BODY—SPICA CASES

By H. EARLE CONWELL, M.D., F.A.C.S., F.I.F.E.L.D., ALABAMA  
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ANY case demanding an application of a plaster body cast with either single or double spica of the hips, thighs and legs is a great care from the treatment and nursing standpoint and frequently the patient suffers considerable discomfort. The prevention and treatment of pressure sores, the changing of the bed linen, any inspection of the perineum, buttocks or sacrum, any dressing of the back and the other usual daily nursing cares are problems of great concern. Cases of this type are frequently improperly handled, thus causing unnecessary pain as well as increasing the possibility of further damage to the patient.

We have found that the overhead frame here with described (Figs. 1 to 6) is a great aid in treating and nursing the plaster body—spica cases; furthermore it eliminates many of the complications and difficulties encountered in such cases.

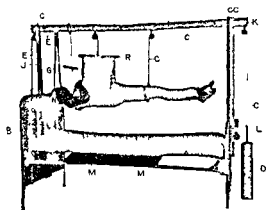
The frame is of very simple construction, consisting of 4 pieces of wood, by 4 inches and a crosspiece (38 by 15 by 15 inches) for extension on the legs when necessary. The frame fits any hospital bed and alterations can easily be made to fit any type of iron bed.

The frame is also useful for treating fractures about the hip joint and fractures of the neck and shaft of the femur, especially if extension is desired either a plaster cast and extension or suspension and extension with the thigh and leg in a Thomas splint being used. We have used it to considerable advantage in fractures of the pelvis.

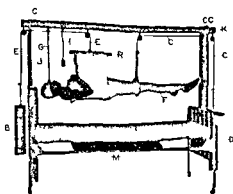
Figure 1 shows the patient suspended following application of sufficient weight to raise him off the bed. K shows crosspiece 2 by 4 by 8 feet 4 inches long which is attached to the foot and head pieces at CC. K extends 6 inches beyond CC. CC at the foot and head pieces to allow the weights to clear the bed. Four 1/4 inch holes, inches apart, are made at points CC. CC on piece K to allow for any adjustment which may be desired of the crosspiece K to the head and foot uprights.

J shows head piece 2 by 4 by 45 feet long. H shows 2 foot up rights (see also Figure 4) which are the same dimensions as the head upright J. Two foot up rights are used to steady the frame.

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f f h d



F



F 2

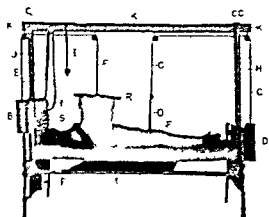


Fig. 3 Showing patient on bed. Weights from B and D have been gradually removed.

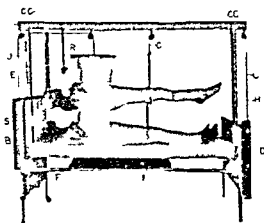


Fig. 4 Double exposure showing patient suspended and lowered.

L shows foot crosspiece 15 by 15 by 38 inches. This is used in cases in which traction on the legs is desired. The screw pulleys are  $\frac{1}{2}$  inches in diameter. U, M show board splints used under the bed to prevent sagging of the mattress.

The patient is suspended with the head and foot weights D and B by attachments of rope C to the double plaster spica F F and rope E to the wooden piece R to which the muslin sling 4 is attached. 1 shows the muslin sling 4 inches by 6 feet which fits around the patient's body cast and at one end of the sling is a loop for the wooden piece R which measures 15 by 15 by 24 inches. Buckles and straps attached to the muslin sling A enable it to be fastened around R. The rope E is attached to the center of R.

G is a piece of bandage around the crosspiece A and has a large handkerchief V tied to each end for the head rest. I is a swing rope and broom stick for patient to pull himself up. S shows blocks (Fig. 5) 45 inches long by 15 by 15 which fit on each side of the upright iron rods on the foot and head of the bed and stabilize the frame.

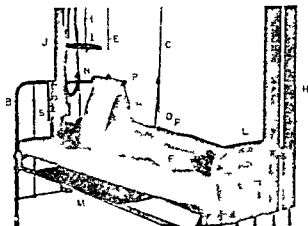


Fig. 5 Close up showing details of cast and suspension apparatus.

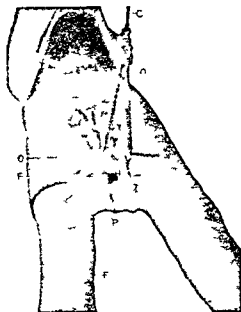


Fig. 6 Showing type of knot tied in the rope O which is applied around the legs F F and the crosspiece P. This crosspiece P which is made of plastic should always be applied because it strengthens the cast as well as allows the patient to be moved painlessly.

It can easily be seen that if enough weight is applied to D and B the patient can be raised at any height from the bed without difficulty and can be suspended for a considerable length of time without great inconvenience to the patient. If any elevation of the patient's head and chest is desired weights can be removed from foot weight D.

Dressing of the perineum can be done easily. Any dressing of the back can be carried out by unbuckling the straps on the right or left side of the muslin sling 1 depending on the location of the wound. The patient is perfectly comfortable and does not suffer from a suspension over a prolonged period.

## CORRESPONDENCE

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### OPERATING RETRACTORS WITH THE FEET

*To the Editor* I wish to call the attention of abdominal surgeons to the advantage of operating their retractors with the feet instead of by hand.

The contrivance is simple. An ordinary gauze bandage is passed around under the table in a loose loop reaching to the floor each end is fastened to a retractor by a strong thumb clamp. The feet of the operator treading upon or secured to this loop of bandage by motion of right and left either of foot or knee make desired traction.

A firm retraction of either or both all of the wound is thus afforded as desired entirely at the operator's command whether seated or standing. The maneuver with a little practice becomes quite automatic. An unobstructed view of the interior is obtained without obstruction of light. One or more assistants are dispensed with as is the necessity for rectifying their action much time and disturbance is saved.

A more elaborate mechanism by which bandages are replaced by metal chains by which hooks pass over other holler grasp the retractor a frame or movable calipers on the principle of a self retaining retractor to the pedals and clamping adjustment attached to the bars of the table through which the bands pass in order to hold them conveniently as well as block and tackle pulleys to increase the retraction with less foot motion etc. have been suggested. Such detail could be left to an ingenious instrument maker should they desire it. Every thing however which detracts from simplicity and asepticity should be dispensed with unless of marked advantage. If additional retraction in any direction is desired there is nothing to prevent an assistant making it when called upon to do so but this is not usually necessary.

I am employing the method described in my operating room where it is being commented upon.

O'NEIL K. L. M. D. F. A. C. S.

K I yl

# EDITORIALS

## SURGERY, GYNECOLOGY AND OBSTETRICS

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APRIL 1928

### INFLUENCE OF PREGNANCY ON THE FUNCTION OF THE GALL BLADDER

IT has been observed clinically that pregnancy is an etiological factor in disease of the gall bladder. In 1911 W. J. Mayo stated that most women with disease of the gall bladder who have borne children date the onset of symptoms from a particular pregnancy. Pre-existing cholecystitis often undergoes exacerbation during pregnancy. It is not uncommon for attacks of gall bladder colic to become so frequent and severe or symptoms of acute or subacute cholecystitis so apparent that operation on the gall bladder must of necessity be performed during pregnancy. It has been demonstrated that such an operation may be done successfully and without undue risk.

It has been assumed that disease of the gall bladder during pregnancy is caused by an increase in the cholesterol content of the blood and a certain sluggishness of the biliary tract produced by pressure from the enlarging uterus. Mann and Higgins showed recently that the emptying time of the gall bladder in most pregnant dogs, guinea pigs and gophers

is delayed. Following the ingestion of the standard fat meal of egg yolk and cream (Boyden) the gall bladder of the pregnant animal of these three species emptied partially in early pregnancy and less completely as pregnancy progressed. Mann and Higgins believe that a larger number of pregnant animals of these and other species including man must be examined before it can be accepted as a physiological fact that the gall bladder of the pregnant animal is slow to empty. They conclude. However, three considerations are pertinent to the subject. The pathological conditions often associated with pregnancy which may directly or indirectly have some relation to the mechanism of the biliary tract are (1) hyperemesis (2) eclampsia and (3) gall stones.

Is this delay in the emptying time of the gall bladder the result of mechanical, chemical or nervous influences? The mechanical factor apparently has been ruled out. Is it the result of chemical changes in the blood due to pregnancy? Many investigators have attacked the problem of the cause or causes of hyperemesis and eclampsia from the chemical angle. Among these Hofbauer has shown that acute poisoning by histamine, a protein derivative, produces pathological changes in animals suggestive of those in women who die from eclampsia and that chronic histamine poisoning produces changes similar to those resulting from pernicious vomiting. Is it the result of action through the sympathetic nervous system? An indication of the influence of the sympathetic nervous system is the frequent observation that pylorospasm occurs during labor, preventing the downward



passage of food even throughout protracted labor. A case may be cited that of a woman who swallowed air and as a result her stomach became distended three times during the second stage of labor. Each time the stomach became visibly distended the patient complained of epigastric pain and the uterine contractions ceased until the stomach was emptied by tubing. Another clinical observation is the induction of uterine contractions following vigorous intestinal peristalsis such as that produced by castor oil. Is the retardation of the gall bladder function due to a similar mechanism? Is the delayed emptying of the gall bladder associated with physiological lowered hepatic function during pregnancy? Is it a part of a retardation or lowering of the function of the upper digestive tract? Artz has observed that gastric acidity is low in certain normal pregnant women and still lower in certain patients with hyperemesis. Is it due to or a part of reversed intestinal peristalsis which may occur during pregnancy.

ROBERT D. MUSSEY

### TREATMENT OF POSTOPERATIVE HÆMORRHAGE FOLLOWING GASTRO-ENTEROSTOMY

**H**ÆMORRHAGE following gastro-enterostomy, rare though it may be, is a most alarming, distressing and embarrassing sequel to an otherwise satisfactory operation and it may tax the best judgment of the surgeon to carry on to a happy and successful outcome.

Hæmorrhage is most likely to occur either at the ends of the stoma or from one of the larger vessels along its margin.

In performing gastro-enterostomy the utmost care should be taken to obtain accurate approximation of the mucosa and to control the submucosal vessels. A lockstitch for the anterior as well as the posterior row of su-

tures is to be preferred, the *anterior mucosal border being turned away from the lumen*. This is exceptionally important because cases of postoperative hæmorrhage have been reported in which the bleeding came from the anterior border due to an inverting mucosal suture which did not control the vessels (Horsley). When a definite vessel can be identified a double lock or back stitch should be used about it. When the gastro-enterostomy is performed without clamps and when all bleeding points may be seen and grasped the chances of postoperative hæmorrhage should be less. If clamps are used two simple straight intestinal clamps suffice. After the posterior row of sutures is completed and again after the anterior row is finished if any possibility of hæmorrhage still exists these clamps may be loosened, any bleeding points may be seen and sutured or ligated and the clamps again tightened. This is especially advantageous when the gastric vessels are abnormally large or dilated.

Dean Lewis has suggested that he considers that the best hæmostasis is obtained with three rows of sutures: serosa, submucosa and mucosa.

When clamps are used approximation of the ends of the gastro-enterostomy incision is facilitated by grasping a sufficiently large section of stomach and jejunum. Thus the stoma is made long enough and yet on rounding the corners tension on the suture line is avoided by not approaching too close to the clamps.

Slow or minor hæmorrhage, the vomiting of dark blood 8 to 10 hours after the operation with gradual tachycardia, requires little more than the withholding of fluids by mouth, the intravenous subcutaneous or per rectum administration of saline solution, transfusion or occasionally lavage. For lavage a weak soda and salt solution at a temperature

of 120 degrees F is especially recommended by Horsley

But when hæmatemesis begins 3 to 4 hours after the operation with definite clotted blood and is repeated 3 to 4 hours afterward the pulse rate is increased and the blood pressure descends there is definite pallor and the hemoglobin and red blood count show well marked hæmorrhage a more drastic and direct attempt to control and check the hæmorrhage must be considered—that is the advisability of obtaining direct control of the hæmorrhage through a gastro-tomy incision must be taken under consideration

The patient is returned to the operating room Under local light gas or ethylene anæsthesia the abdominal wound is re opened or a new epigastric midline incision is made the anterior wall of the stomach about opposite the gastro enterostomy is grasped and a longitudinal incision 6 to 7 centimeters long made into its cavity about midway between the lesser and greater curvature This incision is then held open by stay sutures or Allis forceps and small retractors The clots and debris in the stomach are gently sponged out or aspirated and the gastro enterostomy wound is grasped by placing a stay suture at each end These are drawn upon and the gastro enterostomy is inverted into the stomach lumen where a lockstitch of chromic catgut No 00 can be rapidly thrown around the entire circumference of the gastro enterostomy When the hæmorrhage is controlled the gastro enterostomy is again dropped back and the anterior gastrotomy wound closed with two or three layers of sutures

This procedure has been used in cases with uneventful recovery

W L ESTES JR

## A DE LUXE EDITION OF OLD BOOKS IN SURGERY

THE ever changing conceptions as to the practice of surgery constitute one of its fascinations As the centuries go by certain masterpieces live beyond the ephemeral contribution of their day and a study of these portrays the definite advances in our profession Some years ago Dr Alfred Brown undertook the selection and review in brief of the great books that mark some of the epochs in surgery These have appeared monthly in SURGERY GYNECOLOGY AND OBSTETRICS The material collected is so valuable that it is with pleasure we learn that Dr Brown now contemplates publishing the reviews in slightly amplified form with the beautiful reproductions of the frontispieces title pages and illustrations as they appeared in his isolated publications This collection will be published in an edition of about three hundred pages with attractive typography and wide margins and will be well bound in distinctive boards—a book that will appeal to all book lovers and make a valuable addition to the doctor's library or an attractive gift for his friends

It will be published by Dr Brown not primarily for profit but as a labor of love from one book lover to another The expense will be such that unless there is sufficient interest on the part of the profession as evidenced by subscriptions received in advance to cover at least the printing costs it will not be advisable for the author to bring out the book The subscription price will be eight dollars and it is hoped that those of our readers who are interested will write to Dr Alfred Brown 1618 Medical Arts Building Omaha Nebraska making reservations for copies

# MASTER SURGEONS OF AMERICA

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## PAUL FITZSIMONS EVE<sup>1</sup>

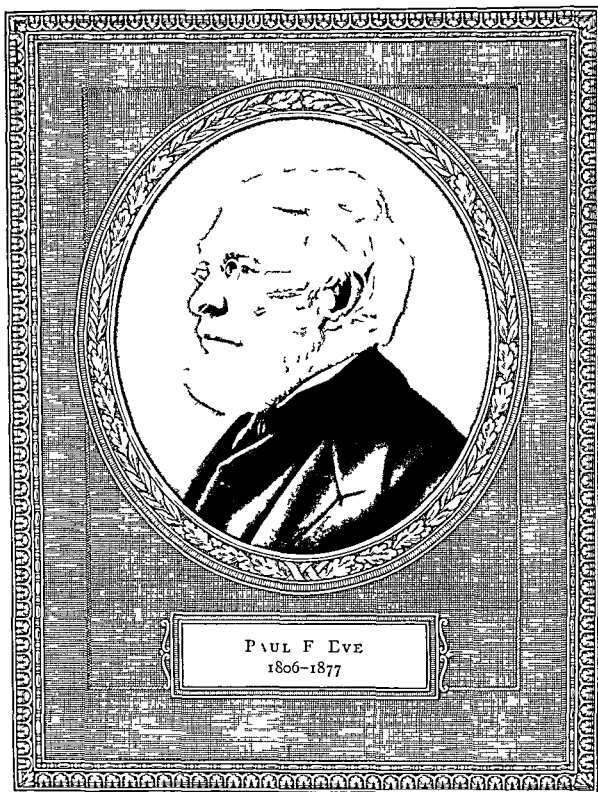
PAUL FITZSIMONS EVE A M M D LL D was born at Forest Hall on the Savannah River six miles below Augusta Georgia June 27 1806 He was the youngest of the eleven children son of Captain Oswell and Aphra Ann Eve On the father's side he was of English descent and on the mother's side was of the Scotch Irish blood His father had been captain of a Pennsylvania company before the War of the Revolution Captain Eve had as a schoolmate Dr Benjamin Rush

Paul F Eve graduated from Franklin College now the literary department of the University of Georgia in August 1826 receiving the degree of A B and the second honor in a class of twenty four This institution later conferred upon him the degrees of A M and LL D In Philadelphia he commenced the study of medicine as a private pupil of Dr Charles D Meigs and graduated in 1828

His original intention had been to remain in Philadelphia after completing the course of study and to practice his profession there He changed his plan because about the time of his graduation his aged father was seriously ill Returning at once to Georgia he gave his careful and unremitting attention to his father who died in 18 9 and this act of filial devotion shaped his coming life for greatness He had in the meantime begun the practice of medicine in Augusta in June 18 8

Dr Eve in November 18 9 visited Dublin Belfast and London where he had letters to Sir Ashley Cooper Abernethy and others He reached Paris in February 1830 and remained there for 18 months following the course of instruction given by Larrey Dupuytren Roux Lisfranc Cruveilhier Trousseau Pecamier Andrae Ricord Louis and Velpeau who was used to introduce him as the tall American surgeon

Dr Eve was in Paris in May 1831 when all Europe was ablaze with turmoil and political excitement He witnessed the dethronement of Charles X in Paris and professionally participated in the revolution of the three days (July 27 8 and 29 1830) Then he went to Poland and offered his services to that unhappy country in its resistance to Russian oppression Remembering how the gallant Pulaski had fallen at the siege of Savannah during the Revolutionary struggle of



PAUL F EVE  
1806-1877



1776 he earnestly desired to aid in paying that debt to distressed Poland. He, at length, reached Warsaw and was assigned immediately to hospital service. For his evident ability and his conspicuous devotion to duty, he was soon promoted from the hospital department to be field surgeon of the Fifteenth Regiment of Infantry and Surgeon of Ambulances attached to General Turno's division. The Golden Cross of Honor was also conferred on him on the recommendation of Count Placé, chief of the Medical Bureau. During the storming and capture of Warsaw on September 7 and 9, 1831, he was fortunately out of the city on duty. He was subsequently taken prisoner, however, and confined at Wierchaw for 30 days, after which he was released under plea of cholera. He reached Paris in October and there rested and recuperated for several weeks. Sailing from Havre, he reached America after a tedious voyage of 53 days.

In June, 1832, Dr. Eve was elected professor of surgery in the Medical College of Georgia, just then organized in Augusta, and was there engaged in teaching for 17 years, bringing the college great reputation and prestige and establishing his own fame as a teacher and surgeon.

In 1849 Dr. Eve was chosen professor of surgery in the medical department of the University of Louisville to succeed Dr. Samuel D. Gross, who went to Philadelphia. He delivered one course of lectures in Louisville, but in March, 1850, he resigned, and although solicited by the unanimous vote of the trustees, the faculty and the students to remain, he returned to Augusta.

In 1851 the medical department of the University of Nashville was organized and Dr. Eve accepted the chair of surgery. This he occupied until the fall of Nashville in 1862, and again after the end of the war until 1877, with the exception of 2 years spent in St. Louis where he succeeded Dr. Joseph Nash McDowell in 1868 in the Missouri Medical College.

He could not be contented away from the South, and in 1870 he resigned and returned to Nashville and lectured to the medical classes of the University of Nashville and of the Vanderbilt University, which then held joint sessions in the same halls. In 1877 he withdrew to aid in the upbuilding of a new school, the Nashville Medical College, afterward the medical department of the University of Tennessee. His death occurred during the beginning of his second course of lectures in this institution.

His success as a teacher and the fame of his teaching may be shown by the records. From the time of its organization in 1832 with 28 students, the Medical College of Georgia increased to 195 students in the session of 1849-50, the last year of Dr. Eve's connection with the institution. This number exceeded the highest ever before or since attained. So in the medical department of the University of Nashville the number of students increased from 136 to 454 for the last session before the war—the largest class then assembled in any medical college in this country outside of New York and Philadelphia.

In 1859 Dr Eve was on the battlefields of Solferino and Magenta and communicated to the profession his observations on military surgery through the pages of the *Nashville Medical and Surgical Journal*

In November 1861 Dr Eve was appointed surgeon general of Tennessee and later chief surgeon of General Joseph E Johnston's army he was also president of the Army Medical Board of Examiners When the fall of Nashville became a certainty and sudden evacuation was determined upon he went away leaving everything he possessed Fort Donelson had fallen Sunday February 16 1862 he left the city at 11 o'clock at night His family servants went with him although he advised them to remain Colonel W K Stevenson was with him nearly blind from inflamed eyes His whole family was out of the city having gone to Augusta to bury his infant child By this forced flight he lost all his property But he went with his own people into exile his instrument case under his arm almost his sole possession

After a hurried visit to Augusta to see his family Dr Eve returned to Chattanooga and was ordered to organize a hospital service at Atlanta He remained in charge of the Gate City Hospital there until just before the battle of Shiloh April 6 1862 when he was ordered to the front He did able and valiant service with the army there and subsequently at Columbus Mississippi where he was stationed for several months Then he was ordered again to Atlanta thence in 1863 to Augusta and for a time to Richmond Virginia After the surrender he returned to Nashville

After the death of his first wife Dr Eve married January 19 1852 Sarah Ann daughter of Rev H D Duncan of Barnwell District South Carolina who survived him nearly 20 years By his second wife Dr Eve had 3 children Duncan Sarah and Paul F Paul F Eve Jr a surgeon of ability professor of surgery and dean of the University of Tennessee died in 1906

Dr Duncan Eve the eldest born in Augusta Georgia May 1 1833 has been president of the Mississippi Valley Medical Society and first vice president of the American Medical Association and has been since 1895 professor of surgery in the medical department of Vanderbilt University

It was in 1875 with all of his family that Dr Eve made his seventh and last trip to Europe

Dr Eve was one of the editors of the *Southern Medical and Surgical Journal* through the years 1845 to 1849 and was also one of the editors of the *Nashville Journal of Medicine and Surgery* from its establishment in 1851 by Dr W K Bowling another president of the American Medical Association to 1873

He also contributed to Johnson's *Cyclopedia* sketches of distinguished physicians of the South and Southwest to the number of 257 a wonderful accomplishment in itself His literary work was unrelenting and reached the prodigious number of 436 papers articles etc the last of which was an address on the His

tory and Achievements of Surgery in the South and Southwest which he delivered before the International Medical Congress at Philadelphia on September 6 1876

In Nashville in 1857 Dr Eve was elected president of the American Medical Association In 1867 he reported to that Association at its annual meeting in San Francisco the synopsis and analysis of 100 cases of lithotomy performed by the bilateral method Altogether he performed 38 lithotomies and had at one operation removed 117 calculi successfully As a lithotomist he was perhaps without an equal in this or any other country Of all his bilateral operations for stone in the bladder only 11 patients died He published the successful performance of amputations of all classes without losing one case up to the fifty fourth the statistics of the major operations comprising 7 of the leg and 7 of the thigh He reported as

Contributions to the Hip Joint Operations 20 amputations and 18 resections performed in the Confederate service He reported 3 cases of gunshot wounds in which the ball lodged in the vertebral column 2 patients still living with remarks on Division of the Spinal Cord without Death He devised an operation for varicocele and invented a cannulated needle for applying ligatures and sutures He was among the first to direct the attention of American surgeons to Esmarch's bloodless method in amputations

The calculi removed he preserved and presented to the Medical Museum of the United States Army The Surgeon General's office in Washington mounted each set of halves placing one set in the Museum and returning the other to Dr Eve The set belonging to Dr Eve was kept in the museum of the Nashville Medical College and was destroyed when the building burned They form in the Medical Museum a collection unequaled in the world as the contribution of a single man

In Professor Samuel D Gross's *History of American Medical Literature from 1776 to 1876* he says 'Professor Eve's collection of *Remarkable Cases in Surgery* as a book of reference possesses great value

When he was in his seventy first year Dr Eve wrote that at the University of Georgia at Athens where he took a 4 years course he never missed a recitation

Took two full courses in the University of Pennsylvania at Philadelphia never was tardy once or missed a lecture While I dare not say that I have done all that I could have done with the means afforded as a medical professor said in Paris when dying yet I hope I can truly declare that I have tried to do so It has ever been with a serious defect in two intellectual faculties sight and hearing I was born near sighted and defective in distinguishing colors The microscope has even been to me a sealed book so has auscultation My hearing is acute but I never could distinguish one note from another I know little or nothing of diseases recognized by differences in sounds or colors What I have done in or for medicine has been with these serious defects



To regular habits of eating sleeping and labor together with his total abstinence from alcoholic stimulants and tobacco he attributed much of his good health health so excellent indeed that for nearly half a century he had not lost a day by sickness and had reached his sixty eighth year before he felt any influence of age

Of noble stature and commanding presence with a splendid head and refined features illumined by the light of genius Dr Eve would have been a distinguished type in any group of the most intellectual of his fellowmen To mental qualifications with which he was plenteously endowed by nature he added the ripe scholarship of a close student His most notable characteristic socially was his kindly sympathy and charitable consideration for the younger members of his profession Dr Eve was a devoted Christian and adorned the church as he adorned his profession This nestor of Southern surgery fell dead between daybreak and sunrise while hastening to see a patient He was in his usual health and in full professional panoply when death summoned him November 3 1877 He fell literally in action with the harness on and

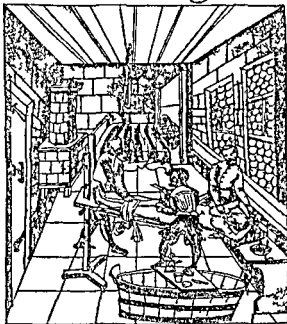
Another chief was carried  
From life's battle on his spears  
To the dim Valhalla cloisters  
Of the evening years

W D HAGGARD



# Practica sopiosa von dem

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# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

BY ALFRED BROWN M D F A C S OMAHA NEBRASKA

### CASPAR STROMAYR'S HERNIOTOMY

THE ancient literature on herniotomy is rather hazy and uncertain as to the detailed technique of the operation. Going as far back as Celsus one finds vague statements concerning opening the scrotum, reducing the contents of the sac and tying it off, and this same indefiniteness and uncertainty persists in nearly all the well known writers up to the latter part of the sixteenth century. To be sure different methods are described. Albucasis as is to be expected uses the actual cautery and burns the tissues down to the bone. In this method of treatment he follows Avicenna and Rhazes and is in turn followed by Bruno of Longoburgo. Other writers—William of Salicet, Lanfrancus of Milan and Guy de Chauliac among them—describe dissecting out the hernia, clamping the sac cord and all and removing the entire mass. Still another group advocates the suturing of the neck of the sac with gold wire, the so called *point doré*.

It is interesting and noteworthy that none of these writers is at all enthusiastic about the operative treatment of hernia. When it comes to medical treatment and the use of appliances, bandages and plasters, they give detailed directions as to technique. One cannot help but feel that the actual operative treatment with its attendant almost universal castration did not appeal. Guy de Chauliac states that he does not believe a proper herniotomy can be performed without castration. On the whole they seem to be willing to apply the Hippocratic statement concerning cutting for the stone to herniotomy and let others who are accustomed to it do the operation. With this indifferent attitude existing on the part of the educated members of the surgical profession, it was only natural that a group of lay herniotomists should assume the burden of caring for this condition. If the responsible members let the opportunity slide by because the burden was too great, the irresponsible members were ready and willing to add another surgical procedure to their repertoire. Consequently, herniotomy, lithotomy and cataract extraction were by mutual consent turned over to the itinerant surgeons who were poorly educated. In many instances they were mountebanks and as a rule wholly worthless and irresponsible tramps. The foundation of the College de St. Come and division of surgeons into the classes of those of the long and short robe gave the itinerant surgeon a

certain standing and conditions began to improve. Brunschwig and Gersdorff wrote their works about the beginning of the sixteenth century. The surgeon of the short robe began to study and impart his knowledge to his fellows and operations of election received a certain standing as compared to operations of necessity. Through the efforts of Ivar, hernia as well as traumatic conditions received attention and in 1556 Pierre Franco published his first work on this subject. There appeared to be little more than Franco's work for a considerable time, but in 1909 a manuscript was discovered in the City Library of Lindau, Lake Constance, which deals largely with the subject of hernia. This has been beautifully reproduced, explanatory historical notes have been added by Dr. Med. Walter von Brunn, Professor of Medical History at the University of Rostock, and the book has been published by Ida Verlaganstalt G. m. b. H. of Berlin.

The manuscript was written and the figures were probably painted by one Caspar Stromayr of the town of Lindau in Lake Constance. The volume is dated July 4, 1559. It is dedicated to Petter Hafner, who is described as wound cutting and eye physician of Zurich. This gives the only point of contact between Stromayr and the medical profession for this Petter Hafner married Anna Ruff, the daughter of Jacob Ruff or Rueff, who wrote the famous *Schoen Lustige Trostbuechle* on obstetrics. Beyond this nothing is known of Stromayr or of his life. He must have been a lay surgeon for his work shows a knowledge which would have given him a standing among the well known surgeons of the world had he been a member of the regular profession. Moreover, in his introduction to the reader, Stromayr stresses the knowledge of the actual condition and the dexterity of the surgeon and deprecates the possession of letters of recommendation and seals and a knowledge of Latin as criteria of ability. In fact, he gives the impression that his opinion of the so called educated physician was not particularly high so far as operative surgery is concerned. He shows interesting colored sketches of various types of hernia and of the operative procedures which he recommends. He does not perform castration and his operation is much like that of Franco.

The point to wonder at is that such a manuscript as this should have lain hidden for three and a half centuries.

## A REVIEW OF NEW BOOKS ON GYNECOLOGY AND OBSTETRICS

By GEORGE GILHORN M.D. I.A.C.S. ST. LOUIS, MO.

WITH the sanction of the Editor I place at the head of the list a book that is neither gynecological nor intended for medical men. Its author has previously published an extensive textbook on therapeutics which it was my privilege to review in the columns a few years ago. What attracted me in that book was not only the crystalline clarity of the presentation and the breadth of knowledge but also the style so beautiful as to be almost unique in medical literature. The author presented facts in such a way as to make them alluringly interesting. I thermore the volume is permeated with golden rays of a pathy humor which rendered study a keen enjoyment.

The same features characterize the present volume. Here the author has intended for the use of the laity. The desire to know something about the body and health and disease is a natural one of our times and is gratified and led into proper channels in the best of the best safeguard against the danger of half-baked and fraudulent claims. In essence the book provides a sound foundation of normal and pathological physiology and when the lay reader has once acquired this knowledge he is able to appreciate better and compare more fully with the efforts of his medical aid.

The author describes his object to four parts entitled respectively: The Human Body as a Unit, The Human Body as an Organism, The Human Body as a Tissue, The Human Body as an Organism for the Reproduction of Itself. On the whole, the Human Body and Diseases and in each of these parts the functions of the various tissues and organs are altered or diseased in the intricate and subtle body etc. are explained in sub-chapters. The list of contents may appear rather too formidable for the average lay reader, yet the author accomplishes his task in an altogether admirable manner. He talks down to his audience though he has frequently recourse to familiar simile or experiences but lifts them up by means of his wonderful diction to a higher level. He blankets ignorance and guesses misapprehensions for many days and banishes and where mankind may more fully enjoy the fruits of a progress of civilization.

No, I do not believe in the millennium but I believe that there is hope and the spell of this book will be better and more joyful. The reader will be more fully able to chuckle at the gems of humor which sparkle through the pages even as I have done as I read the volume from cover to cover. The reader will also be opened to the medical philosophy that besets us on all sides whether

they appear in the garb of so-called regular medicine or as thinly disguised fraud.

Let me give you a few selections for your delectation. If you follow very carefully the dictates of the Life Extension Institute you can live on the average one month longer than you could otherwise. Each period you will spend in bed flat on your back giving explicit instruction to the nurse as to how you want for pall bearers. Speaking of renal colic childbirth is usually set up as the universal standard of pain. I gather from careful research that an ordinary kidney stone colic is equal to childbirth and a miscarriage. Who would not agree with this estimate of the literature on the endo-spheres? Much of this both that intended for physicians and that intended for laymen is put forward with the solemn appearance of fact. Actually it is pure armchair speculation. And of my raiment like me or the fruits of science it falleth upon the just and the unjust. There is only one way to test it with contempt an old Roman remedy. I designate good adjunct no little used in the treatment of disease.

There is a most poetic tenor in his reference to the Rockefeller Foundation the McCormick Institute and similar endowments and his aid to his lay reader some of whom may have funds which they would like to use for the benefit of their fellow human beings that there is no way to use them more effectively than by the endowment of medical research.

There is to me in this book a significance beyond its appeal to the laity. The bulk of most of our textbooks. However they are how difficult to plod through! With the acquisition of knowledge becomes so hard. Here is a textbook on physiology all its aspects of less than 400 pages including more than a hundred instructive pictures. It is as fascinating as the subject itself is fascinating. It is in truth if the average medical student knew as much of the matter as is contained in this book he would know a lot more than he actually carries from school into practice.

TO the thousands of American gynecologists who have not yet had access to radium and acquired sufficient personal experience the book by Clark and Norris will be a most welcome message. As far as I know it is the first attempt in the country to present the question of radium in gynecology in monograph form. We are introverted to the subject by a truly excellent chapter on the physics of radium from the pen of Gioacchino Galia, physicist to the Memorial Hospital in New

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York Here the complicated physicochemical problems involved are cleared up for us as if by a magic wand and we are made to understand the intricate nature of the interaction between matter and radiation of ionization and other scientific factors which underlie the administration of radio active agents such as filtration and the ratio of susceptibility of different tissues

Clark and Norris now take up the story and tell us in the following chapter their clinical observations on the variations in susceptibility of different tissues They stress the importance of teamwork between surgeon pathologist and physicist for successful radiotherapy and insist on exploratory excision of tissue not only for the purpose of making an exact diagnosis at the earliest possible moment but also because the degree of maturity of the cancer cells will affect the method of treatment The danger of rapid dissemination following diagnostic excision or curettage appears to the authors less important than the advantages gained

Quite naturally the greatest emphasis is laid on the use of radium in cancer and there follow four chapters in which malignant tumors of the vulva vagina cervix and body of the uterus are discussed and valuable technical points are presented Of particular interest is the authors own method of cauterization followed by irradiation Their results are encouraging and should prove highly stimulating to American gynecologists

As to fibroids the authors take a standpoint very similar to the one taken by the reviewer some years ago In the question of cervicitis they have followed the lead of Curtis with pleasing results and their experience with membranous dysmenorrhoea proves that this disease is after all not intractable We may finally mention the chapter dealing with pseudomyxoma peritonei granuloma inguinale malignant ovarian tumors sterility and dysmenorrhoea to indicate the wide scope covered in this monograph

To us who have known and loved John Clark it is a matter of sad regret that he did not live to see his book in print but he has left the work in the capable hands of his co worker Norris who has given a work of definite practical value not only to the gynecologist but also the general practitioner who may read therein how much can be accomplished with radium in gynecology

THE socialization of medicine has progressed in Germany much farther than in other countries For the past seven years graduate courses have been given in several German universities where federal state or local health officers school and factory physicians doctors attached to the courts police prisons or sick benefit lodges etc attend lectures on the various branches of medicine The small book before us entitled Social Obstetrics and Gynecology is the crystallization of one of these

courses The author is internationally known as one of the path finders in gynecological physiology and has on his recent visit to the United States made many personal friends He desires to give his readers guide lines in their official sphere of action as far as gynecology and obstetrics are concerned The headings of some of the chapters will explain the scope of the work Regulations regarding the hygiene of the newborn the girl at school age dress of child and woman physical exercises for women and children determination of virginity and motherhood rape legal determination of sex criminality in women general sexual hygiene marriage prenatal and postnatal care social insurance instruction of midwives industrial diseases of women police supervision of prostitutes etc All these subjects are discussed briefly and with reference to existing laws and ordinances Some of these are of course specifically German and have no counterpart in our own legislation A surprisingly large part of the book however applies to conditions in our country as well and as thus far very little attention has been given to the social pathology of diseases of women in our textbooks the American reader will find the study of this unpretentious volume extremely stimulating He will also appreciate the simple and direct style which greatly facilitates the perusal of a book in a foreign language

IN the six years which have elapsed since the first edition of Youngs Gynecology appeared quite a few advances in our knowledge have necessitated a re writing of parts of the book Thus we find in the new edition a discussion of the Rubin method the cyclic changes in the ovary and their bearing on menstruation the curative value of radium the endometrial transplants of Sampson and other subjects A volume of only a little more than 300 pages might well appeal to the student A future edition might be made still more attractive by deleting certain obsolete matters or modifying statements such as the assertion that gonorrhoea can be cured by three or four douches daily of potassium permanganate 1/8000 In favor of the book and of prime importance to the student who is being initiated into this field is the wholesome emphasis which is laid on pathology and diagnosis and the differential diagnosis too for instance in uterine cancer or tumors of the ovary has distinct merit

THERE is no such thing as a sexually frigid woman—that is the leitmotif of Steckels extensive work on anaphrodisia in women Passion may be hidden inhibited repressed or transposed into other channels but it is never wholly absent In these days the art of loving is on the decline

AT THE G. LO. By J. M. H. S. D. S. M. D. FRCS (Ed.) 1 N. W. 1 K. Th. M. H. C. M. P. Y. 97  
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The most marked evidences of this fact may be observed in America where the man is so busy with money getting that love is relegated to a second place. In America too so called sexual anasthesia is very common among women. Yet the hypocrisy of the New World is well known and an exaggerated prudishness on the surface and underneath indulgence in the vilest passions in such unheard of forms as orgies with Niggers and Chinese.

This quotation which proves the danger of generalization from sporadic instances of sexual depravity will show the American reader that not every statement in this book can be accepted at face value. But it would be wrong to condemn the whole work because of a few exaggerations or misstatements. On the contrary we have every reason for learning something about the psychic phenomena in our patients and the question of dyspareunia in particular. A careful observer will admit that mechanistic explanation is the only one which is discussed in our gynecological textbooks and is sufficient in all cases. I dare say that we are already reached from a too one-sided standpoint and that suggestion for curing masturbation or frigidity by electricity or some other operation on the clitoris which formerly seemed quite legitimate no longer appears to us ridiculous and medieval.

It seems to me that Steckel who is a prominent psychoanalyst in Vienna goes to the other extreme that is he explains most gynecological diseases and practically all disturbances of the sexual life by psychological factors. We must however concede that he offers plausible solutions of a good many problems that have heretofore baffled us. There is for instance the oft made observation of husband and wife who have lived in sterile wedlock for years and after divorce each beget children in a second marriage (p. 30). There is the question of effluvium seminis (p. 112) of painful cohabitation in the absence of the probable causes (p. 197) of the psychic etiology of certain forms of vaginal discharge (p. 522) or of imaginary pregnancy (p. 530) and other too numerous to mention here. To offset this we are startled out of our unreserved acceptance of the author's views by a sentence such as this: "To be raped by her own father has been the wish or dream of perhaps every girl at one time or other in her life."

The study of this book therefore requires a good deal of critical judgment and only with this provision might the macrocosm of the soul as expounded by the author be made useful for the diagnosis and treatment of some of our gynecological problems.

## BOOKS RECEIVED

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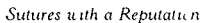








## A R I R O F R T P A T E N T



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# SURGERY, GYNECOLOGY AND OBSTETRICS

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## THE PRECANCEROUS CHANGES IN THE RECTUM AND COLON

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S S g t St M k H p t l

AND

CUTHBERT DUKES M D M Sc LONDON

D t C R h D p t m t f St M k H p t l

ONE of the greatest difficulties in studying the etiology of cancer from a clinical standpoint is that the disease is seldom seen except in the late stages when the growth has already reached a considerable size it is not until then that symptoms are produced. Thus but little is known of the early stages in the development of malignancy and the changes in the normal epithelium which ultimately result in the transition from the normal to the malignant tissue are still but little understood. This is true of all cancers but our study of precancerous conditions has been confined mainly to cancer of the large gut.

In the vast majority of cases of rectal cancer there is nothing in the patient's history pointing to any previous condition which might be a forerunner of the tumor. It has been surmised by some writers that long exsistent piles either internal or external may give rise to cancer if neglected but we have never come across any cases which would seem to lend credence to such a view. It might well be supposed that chronic pruritus ani might lead to the development of epithelioma of the anal skin but we rarely have a case in which this has occurred although epithelioma of the vulva is not an uncommon result of pruritus vulvæ.

Chronic fistula does occasionally appear to act as an exciting cause of cancer and we have records of two cases in which a carcinoma arose at the inner opening of a chronic fistula. On the other hand we have seen fistulæ which have existed for as long as 50 years without the development of cancer. Chronic constipation has been said to be a predisposing cause but there is no satisfactory evidence in support of this view. It must be admitted that apart from adenoma we know of no condition in the rectum which predisposes to cancer with any frequency.

It has been increasingly evident in recent years that the etiology of malignancy cannot be elucidated by the histological study of fully developed tumors and that it is necessary to go further back and study the changes which occur in the epithelial cells before this stage of malignancy is reached. This histological study of the changes which precede the development of cancer in the human subject is handicapped by the difficulty of obtaining suitable material nevertheless notable progress has been made in such investigations. Thus for many organs of the body chronic hyperplastic changes such as those Sir Lenthal Cheate has described in the mamma have been recorded as commonly preceding cancer. In this paper we shall



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provide pathological and clinical evidence that similar epithelial proliferations frequently precede cancer of the rectum

It is now a well established fact that adenomata of the mucous membrane of the large intestine are peculiarly liable to undergo malignant change. The following case will illustrate this process

CASE 1. A gentleman 58 years of age was brought by his doctor to see one of us (P. L. M.) on account of a tumor in the rectum. The tumor was about the size of a two shilling piece, sessile and soft and was situated on the anterior wall of the rectum about 3 inches above the anus. A careful microscopic examination of the tumor after its local removal and after several sections had been cut from different parts of the tumor showed the structures of a simple adenoma. There were no signs of malignant change. The patient returned home after being instructed to have periodic examinations made. He neglected to follow the advice and was not seen again for 15 months. He then had a malignant tumor in the situation of the previous adenoma. It seemed certain that the adenoma had recurred and had subsequently undergone rapid malignant change.

The best clinical examples of the simple adenoma which undergo malignant change and develop into typical carcinoma are seen in those rather rare cases of multiple adenomata or adenomatosis. This curious disease has a familial tendency in fact it is a true Mendelian dominant furthermore malignant change in one or more of the tumors always occurs. Such cases afford us an opportunity of studying the precancerous condition and have been of the greatest value in this connection.

In 1931 one of us (P. L. M.) stated that simple adenoma, whether single or multiple should be considered as a definitely precancerous condition and treated as such. Since then much evidence has accumulated to con-

firm this view. The histological examination of large simple adenomata by cutting several sections from different parts has not infrequently demonstrated commencing malignant change in one part of a tumor which was otherwise benign in character. We need not dwell longer on this point since the frequency with which cancer begins in adenomata is now more generally admitted and in a recent paper one of us has reviewed from the pathological aspect the relationship between simple and malignant tumor of the large intestine. In the bibliography we append references to the articles which have appeared in the last 2 years in each of which the close relationship of adenoma to carcinoma is emphasized.

#### RELATION OF EPITHELIAL HYPERPLASIA TO ADENOMA

If the piece of bowel which is removed by the operation of excision for cancer of the rectum is pinned out immediately to prevent distortion and after fixation in 10 per cent formal saline examined with a low power microscope or powerful lens the mucous membrane will often show irregularities in contour not visible to the naked eye. We have noticed the irregularities particularly in two pathological conditions—multiple adenomata and early cancer of the rectum. On section and microscopic examination of such an area of the bowel the irregularity is seen to be due to a localized epithelial hyperplasia. The hyperplasia may be so slight as to be quite invisible to the naked eye and only detectable on microscopic examination (Fig. 1) or it may be large enough to be noticed as a tiny smooth rounded elevation (Fig. 2). This irregularly distributed hyperplasia represents the first stage of tumor formation.



Fig. 3 Adenoma of the rectum. One of many tumors found scattered over the mucous membrane of the rectum in a case of early cancer

and we wish to draw attention particularly to three points with regard to it (1) that it is found most frequently in association with multiple adenomatosis and cancer of the rectum (2) that it is more likely to be found in the neighborhood of a small malignant tumor than a large malignant ulcer and (3) that it affects an extensive area of the bowel several inches above and below the cancer.

No sharp line of distinction can be drawn between this hyperplasia and adenoma. In practice we reserve the term adenoma for a glandular tumor visible to the naked eye and class as hyperplasia similar changes on a smaller scale only visible on magnification. Histological examination of adenomata (Fig. 3) proves that they represent only a more advanced stage of hyperplasia necessitating an architectural modification in the normal relationship of epithelium to connective tissue in order that the greater number of secreting cells can be supported and adequately nourished.

#### SEQUENCE OF EVENTS IN THE DEVELOPMENT OF CANCER

If it were possible to preserve a record of the condition of the mucous membrane of the rectum for several years before the appearance of a malignant tumor we believe that in the majority of cases the following stages would be noticed in sequence though naturally the number of years elapsing between each stage would vary greatly from patient to

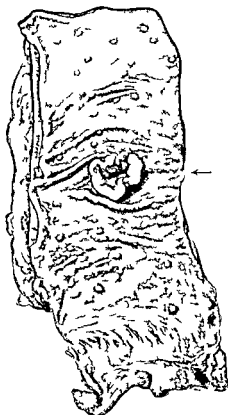


Fig. 4 Malignant disease commencing in adenoma of the rectal mucous membrane. The malignant change is limited to the top and one side of this tumor but cancer cells are to be seen also invading the submucosa (indicated by the arrow).

patient. *First stage* localized patches of hyperplasia invisible to the naked eye but discoverable with the microscope affecting an extensive area of the bowel. *Second stage* the appearance of a crop of sessile adenomata scattered over as wide an area as was affected by the initial hyperplasia. *Third stage* the development of cancer either in one of these pre-existing adenomata (Fig. 4) or in the neighboring epithelium. *Fourth stage* the progressive enlargement and dissemination of the malignant tumor accompanied by retrogression of the hyperplastic changes and benign tumors surrounding the malignant growth.

#### THE PRECANCEROUS STATE

Both experimental and clinical observation have shown that the onset of carcinoma is commonly preceded in different organs of the body by a precancerous condition of the epithelium. In the rectum this precancerous state is distinguished by irregular patches of hyperplasia of the mucous membrane and adenomatosis. This does not mean every patch of hyperplasia will evolve into an adenoma or every adenoma into a cancer. The hyperplasia may disappear an adenoma may become pedunculated and be shed or



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at any stage the onward march may be arrested. In experiments upon mice we find that not every mouse painted with tar develops papillomata and not every papilloma becomes an epithelioma nevertheless we can say that the common sequence of events when mice are tarred is hyperplasia papilloma and epithelioma. The papilloma is the precancerous stage in experimental tar cancer and the adenoma is the precancerous stage in human rectal cancer.

We cite the following clinical evidence in support of this assertion.

#### CLINICAL EVIDENCE IN SUPPORT OF CONCEPTION OF A PRECANCEROUS STATE

The following cases illustrate what we regard as stage in the development of cancer of the rectum.

**CASE 2** A patient 66 years of age was admitted to St. Mark's Hospital with complaint of bleeding from the rectum. The first symptom was noticed only 14 days previously when after an urgent call to defecate the patient observed that he had passed a little blood. Sigmoidoscope examination showed a small tumor in the rectum. A perineal excision was performed.

The piece of intestine removed at operation is shown in Figure 5. The tumor was about 1 inch in diameter and projected  $\frac{1}{2}$  inch above the surface of the bowel. The mucous membrane of the rectum above and below was covered with adenomatous growth of them about  $\frac{1}{8}$  inch in diameter. When the mucous membrane was stripped off the submucosa it was obvious that the tumors consisted entirely of an epithelial hyperplasia and were not caused by a bulging inward of the submucous coat. Nine adenomata could be counted in a square inch of the bowel above the growth and they were almost equally numerous else here.

Microscopic examination showed the central tumor to be an adenocarcinoma. The cancer cells were seen to have invaded the submucosa but not as far as found within the muscle wall. The small tumors round about were seen to be composed of glands of mucus secreting epithelium and were true adenomata.

This case is specially noteworthy because of the early stage of the cancer as shown by its small size and brief history and because of the widespread adenomatosis which we believe to be a special feature of early malignant disease of the bowel.

**CASE 3** A patient 47 years of age was admitted to St. Mark's Hospital complaining of bleeding from the rectum. He gave a history of bleeding a day or so more for about 3 months. Cancer of the rectum was diagnosed by sigmoidoscopic examination and a perineal excision was performed.

The specimen removed at operation is shown in Figure 6. The cancer had the appearance of an oval shallow ulcer 2 inches in diameter extending half way round the bowel wall. The mucous membrane above the growth was dotted with adenomatous growth being on the average 6 to 12 tumors per square inch. There were less numbers below but could be seen almost as far down as the mucocutaneous junction. Microscopic examination on show the tumor to be an adenocarcinoma infiltrating the muscle wall of the bowel. The adenomata had the same microscopic characters as those of Case 2.

**CASE 4** A patient 67 years of age was admitted to St. Mark's Hospital complaining of losing weight for 7 months and diarrhoea with increasing loss of blood and mucus. Cancer of the rectum was diagnosed and a perineal excision performed.

The piece of intestine removed at operation is shown in Figure 7. In the upper part of the rectum

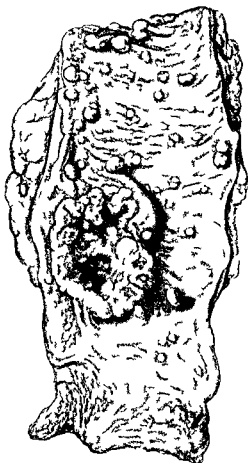


FIG 6 Cancer of the rectum associated with adenomatosis. Note the extensive area of the bowel which is covered by the benign tumors and the comparatively small area affected by malignant disease

was a large fungating ulcer  $3\frac{1}{2}$  inches in diameter which had extended almost completely round the bowel wall (tumor A). At the lower extremity of the rectum was another large irregular fungating growth extending completely round the bowel and obviously composed of 3 or 4 separate tumors united into one mass (tumor B). Between these large upper and lower tumors 3 other separate tumors  $\frac{1}{2}$  to 1 inch in diameter projected from the bowel wall. The intervening portions of the bowel wall appeared to be healthy. Microscopic examination showed the upper and lower tumors and the largest of the 3 intermediate tumors (tumors C) to be adenocarcinoma; the submucosa beneath each being invaded by malignant cells. The other tumors showed no indignant changes. Thus in this case 3 separate malignant growths and several benign adenomata were present in the rectum and sigmoidoscopic examination revealed other tumors in the sigmoid flexure of the colon.

Multiple foci of cancer in the rectum are not common. We have collected a few specimens at St. Mark's Hospital of 2 separate malignant growths but this is the first instance of 3 malignant growths in the rectum.

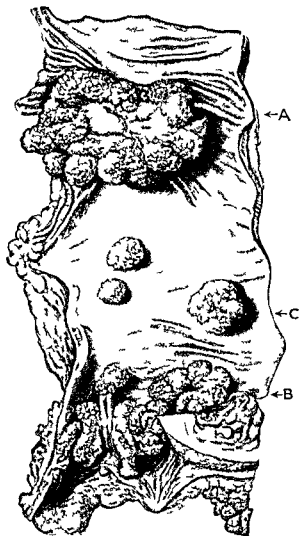


FIG 7 Cancer of the rectum accompanied by adenomatosis. In this case 3 separate malignant tumors (A, B and C) are present. Beneath each the submucosa is invaded by cancer cells but the intervening tissues show no infiltration. This is a case of cancer supervening on adenomatosis the malignant disease commencing at 3 separate places.

The following case illustrates the extensive area of bowel which may be affected by adenomatosis and the value of the discovery of adenomata as suggesting neighboring malignant disease.

CASE 5 The patient was a gentleman 58 years of age who came to have a large pedunculated adenoma removed from the rectum. At operation an adenoma as large as an orange with a long pedicle attached about 4 inches above the anus was easily removed. It was then discovered that there was another adenoma quite as large as the first impacted in the upper part of the rectum. This was removed with considerable difficulty as although it was pedunculated it was so large that at first it could not be pulled past its own pedicle which was attached below it. After the removal of the second adenoma a sigmoidoscope was passed



and a third adenoma as large as the others was seen in the sigmoid flexure. The abdomen had to be opened so that this adenoma could be removed. It was situated in the lower third of the sigmoid colon and part of it had undergone malignant change and involved the bladder wall.

As an illustration of the fact that adenomata occur as the result of a hyperplastic change which has affected an extensive area of the mucous membrane the following case is of particular interest.

**CASE 6** A gentleman 6 years of age came for treatment of a large adenoma high up on the posterior wall of the rectum. Local removal of the mucous membrane including the adenoma was made and the patient has been carefully watched since. During the course of 6 years from the time of the original operation for adenomata have been removed at different times. None of these adenomata was in the strict sense a recurrence. None of them arose in the situation of the original tumor but in other parts of the total mucous membrane some distance away.

Another exactly similar case has been under observation for 5 years and 4 different tumors have been removed none of which was in the situation of the first tumor.

Had these patients not been examined at regular intervals large tumors would have developed which would have been certainly looked upon as true recurrence. The truth seems to be that adenomata once removed do not tend to recur in the same spot but other adenomata tend to develop in the neighboring mucous membrane. In other words they arise as the result of the occurrence of progressive hyperplastic change not in one spot but in a fairly extensive area of the bowel epithelium.

If this view of the sequence of events is correct the condition we have described as multiple adenomata is one that should be watched most carefully. One of us has shown in an article on Cancer and Heredity how frequently cancer is associated with multiple adenomatosis and has explained the apparent hereditary tendency to rectal cancer in certain families as due to the familial incidence of multiple adenomatosis. Since multiple adenomatosis is so frequently an early stage in the development of cancer it is imperative that a patient in whom this condition is dis-

covered on sigmoidoscopic examination should be kept under strict observation.

#### SUMMARY

The earliest recognizable lesion in the development of cancer of the rectum is a hyperplastic change taking the form of irregular epithelial proliferations scattered over an extensive area of the bowel.

This is followed by the appearance of visible tumor—adenomata—these are usually numerous and often separated from each other by several inches of mucous membrane normal in appearance to the naked eye. We have called this the precancerous stage.

The bowel may remain in this condition for many years or at any stage in the epithelial proliferations or at any stage in the growth of an adenoma the epithelium may abruptly assume those invasive properties recognized clinically and histologically as cancer.

It would appear that carcinoma formation is an accident happening to a previously existing adenoma. With the development and dissemination of the malignant tumor the neighboring epithelial proliferations and benign tumors tend to retrograde and disappear so that they are less evident in association with large malignant ulcers.

The foregoing opinions are supported by pathological and clinical observations.

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## THE FATE OF IODIZED OIL (LIPIODOL) IN THE LUNGS

BY A LINCOLN BROWN M D SAN FRANCISCO CALIFORNIA

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THE introduction of iodized oil in the form of lipiodol into the field of radiology by Sicard and Forestier (6) in 1921 has been followed especially of late by its widespread use in the exploration of the bronchial tree. Reports are now available from numerous clinics where fairly large series of cases have been injected. But scientific therapeutics presupposes an intimate and exact knowledge of the physical and physiological effects upon the organism of the substance administered from the moment it enters the body until its elimination is completed. Although as a rule the use of a drug is to be deplored when this knowledge is incomplete still if the drug has been shown to possess certain advantages then its use must be condoned until further light either strengthens or weakens the authority for its administration. This is the present state of affairs with respect to the intratracheal injection of iodized oils.

It is known that certain dangers exist in the introduction of the material into the tracheobronchial tree (1). The knowledge of the absorption, elimination and physiological action of the iodine component of the mixture is relatively complete. But the same cannot be said of the oil portion. Therefore the experiments reported in this article were undertaken with the aim of studying (a) the reaction if any of the finer structure of the pulmonary tree to the presence of iodized oil and (b) the fate of the oil portion of the combination. In these experiments the French preparation lipiodol was employed. This consists of a vegetable oil, huile d'oeillette, and contains besides 40 per cent of iodine by weight. The iodine is said to be in chemical combination with the oil which combination breaks up slowly once the oil is in the body but is otherwise fairly stable. Forestier has shown that after an intratracheal injection of 20 cubic centimeters of lipiodol the daily elimination of iodine (mainly via the urine) during the first 2 weeks is about 2 centigrams.

The iodine makes its appearance in the urine in about 10 hours.

The recent work of Roger and Binet (4) suggests that the lung possesses besides its usual function of filtering gases an internal digestive power which is most strikingly exhibited in its action on fats. In their investigation they make use of intravenously injected oils and they believe that the fat is altered by a true intravascular digestion in which oxidation plays the most important role. Their observations however were concerned with the fate of oil on the blood vessel side of the air capillary membrane while we are dealing with oil introduced into the air side of this system. The experiments of Gueysse (3) extended and confirmed by Guyot throw some light on this phase of the problem. They injected small amounts of purified olive oil intratracheally into the lungs of rabbits and made histological preparations of the lungs 1 and 4 days after the introduction. They found that after 24 hours the drops of oil in the alveoli were in a state of decomposition were irregular jagged and filled with vacuoles and that by the fourth day this process was still more marked. They believed the oil to be absorbed by the epithelial cells of the alveoli. However when they used larger doses of oil they found that a certain number of the epithelial cells detaching themselves from the alveolar wall phagocyte the oil and migrate through the adventitia as far as the lymph nodes. On the other hand Sicard (6) states that the oil which remains in the lungs for longer periods of time probably becomes encysted. It seemed to the writer that further experimental work in this direction was worth while.

## EXPERIMENTAL METHOD

Lipiodol was introduced into the tracheobronchial tree of cats under light general anesthesia by the intercostothoroid route. A small syringe was first attached to a heavy needle and the latter inserted into the



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trachea its position being determined by the free aspiration of air into the syringe. This syringe was then replaced by another containing warmed lipidol and 2 cubic centimeters of the oil were introduced. The injection was carried out with the cat fastened upon an animal board and placed on an inclined plane of 30 degrees head up so as to facilitate the flow of the oil into the inner bronchi. In some instances cough was induced shortly after injection. The trachea was compressed at the same time as this procedure has been shown to further the penetration of the oil. ( ) X ray picture were taken in each case shortly after the injection to make clear the presence and general position of the oil in the tracheobronchial tree and were repeated at interval of 1 to 3 days throughout the remainder of the life of the cat. The excellent radiographic properties of the oil rendering it peculiarly adaptable to this phase of the work. The cats were then killed by bleeding at various intervals from 1 hour to 26 days after injection and autopsied the lungs in each case being preserved in 10 per

cent formalin. A glance at the last X ray picture of the lung in question usually demonstrated the portion of the lung containing the oil in greatest amount and histological sections were taken through that area in which the presence of the oil had been demonstrated at some previous time. Two series of slides were made one the usual hematoxylin and eosin preparation to demonstrate any cellular reaction and the other frozen sections stained with Sudan III or Scharlach R and mounted in Farrant solution to demonstrate the oil itself. The sections were cut thick (25 to 35 microns) so that the larger droplets of oil would not fall out.

The detailed typical and histological findings in the experiments were carefully noted. In all cases roentgenograms taken shortly before the death of the animal demonstrated the iodine component of the oil to be present in larger or smaller amounts. Actually this amount appeared to vary as seen by subsequent microscopic examination in direct proportion to the amount of oil found in the tissues. That is although the absorption and elimination of the iodine proceed at a more rapid rate than the oil still the more oil there

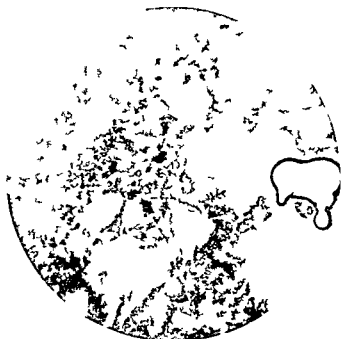


Fig 3 Cat 4. Photomicrograph of a portion of the pleura. The dark staining elements collected especially just beneath the pleural surface are mononuclear phagocytes filled with droplets of oil. Lens 16 millimeters 8 times ocular 20-inch bellows Sudan III stain

is in the tissues the more iodine is also present

From these histological studies it appears that phagocytosis is a prime factor in the absorption of oil from the alveoli and that these phagocytes then transport the material by way of intercellular migration to lymphatic channels and lymph nodes. The cells concerned in the process of phagocytosis are large mononuclear cells apparently of endothelial origin. In the earlier days after introduction of the oil these cells are most prominent in the neighborhood of the oil filled alveoli and in the alveolar spaces themselves while as the process progresses they are observed also in large numbers collected in groups in the lymphatic areas and nodes and finally even after the alveolar spaces have got rid of the oil these groups of phagocytic cells containing the oil still stand out prominently.

It was noted that the distribution of these oil containing phagocytes during the process of migration (Fig 1) closely follows that of the lymphatics of the lung as described by Schaefer (3). The passage reads as follows

*Lymphatics* The veins are accompanied by lymphatics which commence both in the



Fig 4 (left) Cat 4. Twenty four days after the lipiodol injections. In this cat 2 injections were performed at the outset the first intratracheally and the second into the subcutaneous tissues of the neck. That in the lungs still persists in a finely spread state in the middle and lower right lobes. It is from this area that sections were taken for microscopic examination. The mass in the neck is well defined and microscopic sections here show the oil to be well encapsulated. No such process of encapsulation was noted with respect to any of the oil in the pulmonary tissues

Fig 5 Cat 1. Four days after the introduction of lipiodol. Roentgenographic shadows show the oil to be present in large amounts in the middle and lower right lobes. Sections for microscopic examination were taken from this area

interalveolar tissue and under the pleura and pass to lymphatic glands at the root of the lung. Others which eventually join these accompany the arteries and others are found in the walls of the bronchial tubes. There are no lymph vessels distal to the lobular bronchioles. The lymph vessels of the bronchi send branches to join those of the pulmonary arteries and veins. These communicating branches come from the end of the lobular bronchioles and from the places where the bronchial tubes branch. The atria and infundibula (air sacs) have no lymph vessels in their walls. The lymphatics of the lung often contain large mononuclear leucocytes (phagocytes) with carbon particles in their interior. The carbon particles are introduced with the air of respiration and appear to be conveyed

from the interior of the alveoli into the pulmonary tissue by the agency of leucocytes which are often seen in sections of lung within the air cells (Fig. 2).

The rate of removal of the oil appears to be in direct proportion to the number of these phagocytic cells which may be marshalled into action in any given area. Thus if there be only a small amount of oil in a given region it is quickly removed whereas if many neighboring alveoli are filled with oil the process is markedly prolonged probably because of the lack of sufficient phagocyte to expedite the work as well as of a mechanical block of tissue and lymphatic spaces (in which the phagocytes migrate) by the pressure of the oil (Fig. 3).

In no instance even when oil was found in alveoli after a period of 4 weeks was there any evidence of encapsulation of the oil. This encapsulation has been suggested as being the fate of oil remaining in the lung for long period of time but we are unable to adduce any confirmatory evidence on this point. In contrast to this we have observed encapsulation of masses of oil injected into the intermuscular spaces of the neck to take place as early as 1 week after the introduction of the oil.

Although the most important factor in the removal of the oil appears to be a process of phagocytosis comparable to the removal of dust particle from the alveoli there is probably also a certain amount of direct absorption of oil by the lining cell of the alveoli themselves but this appeared to be of secondary importance. Perhaps there is also a certain digestion of oil and absorption into the blood system is suggested by the work of Poger and Binet but there is no evidence in support of this in the material at hand nor did we note any vacuolization of the oil in the alveoli as suggested by Guieysse.

#### DETAILED HISTOLOGICAL FINDINGS

CAT 3 (Autopsy 4 days after introduction of oil). (Slides stained for oil). Lipid is scattered in a state of fine dust throughout numerous alveoli. Many of these are completely filled with the oil. Apparently oil also bedded by the endothelial cells of the alveoli and is collected in large masses in the connective tissue around the smaller

bronchi and pulmonary veins. Nowhere do droplets of oil appear vacuolated. In those areas where lipoid is found in greatest amounts there is a marked infiltration of leucocytes most of which are mononuclear several being of the large phagocytic variety and many of which show oil inclusions. In some areas the pleura shows collections of the oil in a very fine state of subdivision. Here also it is mainly present as inclusions within large mononuclear phagocytes.

B (Hematoxylin and eosin slides). Small hemorrhagic areas are scattered throughout the lung along with the cellular infiltration of the tissues which is predominantly mononuclear in character. In the same areas are noted masses of yellow brown staining material which is similar to hemosiderin in appearance. This cellular infiltration is especially marked around the pulmonary vessels and bronchi. No thickening of the pleura is noted although the infiltration and hemorrhage extend directly up to the pleural surface.

CAT 23 (Autopsy 24 hours after introduction of lipoid).

A (Slides stained for oil). Large areas of the sections examined show many of the alveoli completely filled with the oil and others containing it in greater or smaller amounts. Throughout the infested areas a moderate leucocytic infiltration prominently of the large mononuclear variety is noted. The cytoplasm of many of these cells is filled with minute droplets of oil. In some instances these cells are observed in what may be supposed to be the actual process of phagocytizing the oil. However no actualization or puncturing of the large droplets by these phagocytes is noted. The phagocytic cells are observed both free in the alveolar spaces and also apparently in the process of migration through the pulmonary vessels. In those areas in which only a few of the alveoli have been filled with the oil the process of phagocytosis has proceeded most rapidly and here also are noted large numbers of phagocytic cells. These cells are likewise collected in groups about the walls of the bronchi. Immediately beneath the pleural collections of the oil contain many mononuclear phagocytes as also seen.

B (Hematoxylin and eosin slide). In some areas there is a marked mononuclear infiltration. These cells correspond to the phagocytic type and are found in greatest numbers about the walls of the alveoli and in several instances in large amounts free in the alveolus. A few of these cells contain one or more vacuoles. They are also noted scattered just beneath the visceral pleural surface.

CAT 4 (Autopsy 4 days after the introduction of lipoid).

A (Slides stained for oil). Small droplets of oil are scattered throughout large areas of the lung. Many of the alveoli are almost completely filled with phagocytic leucocytes in whose cytoplasm numerous fine droplets of oil are noted. In some instances the whole cellular structure of the lung is apparently permeated with these very fine droplets. About the

nuclei of the cartilage cells and in the cytoplasm of these cells are collections of oil. The pleura is thickened and covered with an exudate which likewise contains large amounts of oil finely subdivided. In some areas there is evidence of old hemorrhage and throughout the regions involved there is observed leucocytic infiltration predominantly mononuclear in character.

B (Hæmatoxylin and eosin slides) The areas about the pulmonary vessels and bronchi show a marked infiltration in which large mononuclear cells predominate. The pleura is thickened and infiltrated throughout with these cells. In other portions the lung has completely lost its structure and contains multiple abscesses.

#### SUMMARY AND CONCLUSIONS

An iodized oil (lipiodol) was injected intratracheally in 2 cubic centimeter amounts into the lungs of healthy cats. These cats were killed anywhere from  $\frac{1}{2}$  hour to 26 days after the introduction of the oil and histological studies of the lungs undertaken. From these studies it appears:

1 That the presence of oil in healthy alveoli excites a mononuclear infiltration of the area involved.

2 That this mononuclear infiltration is of the large phagocytic type apparently endothelial in origin.

3 That these phagocytes are the prime agents in the removal of the oil from the alveoli and that they follow the lymphatic system while direct absorption or digestion of the oil if it occurs at all is of secondary importance.

4 That at least up to 4 weeks there is no evidence of encapsulation of the oil remaining in the alveoli and

5 That the rate of removal of the oil is in direct proportion to the number of available phagocytes.

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## FURTHER STUDIES ON CLOSURE OF BRONCHI IN LOBECTOMIES (EXPERIMENTAL WORK)

By RALPH BOERNE BFTTMAN M D F A C S WILLIAM A JAMES M D  
KARL TANNENBAUM M D E SLOBF M D Ch Cag  
F m th D p tm t f E p um t i S g y N h w L M d i Schoo

IN a paper written by one of us several years ago<sup>1</sup> experimental evidence was advanced to show that it is difficult to close bronchial stumps after pneumectomy because the structures which go to make up the stump are in themselves unable to close the bronchus. When a bronchial stump heal it does so usually because of the activity of some extrabronchial tissue most frequently the pleura from adjacent lobes. In our experiments at that time we reported a series of dogs in which after a complete pneumectomy the vast majority died suddenly on the fifth or sixth day because of the failure of the bronchial stump to heal. It took about 5 days for the ligature which closed the bronchus to slough and allow the bronchus to re open. As long as the bronchus was held closed by the ligature the dogs were in good condition. As soon as the stump sloughed and the bronchus re opened the dogs died from internal pneumothorax. In this series one dog survived and later was killed. Microscopic section showed that the bronchial closure was accomplished by a very thin membrane and it was a source of surprise to us that the membrane had not torn on the first paroxysm of coughing.

In this same article we reported a second series of experiments in which instead of removing the entire lung on one side we removed only one or two lobes of the lung leaving one or more lobes in place. The great majority of our dogs lived. On autopsy it was found that the bronchial stump had become buried in adhesions usually derived from the pleura of contiguous lobes and that these adhesions derived from peribronchial tissue had closed the stumps, the actual tissues in the stump itself had not been active in the healing process. We made the statement at that time that although the main bronchus was ex-

tremely difficult to close and that complete one sided pneumectomy almost invariably resulted in death on the fifth or sixth day due to opening of the stump a lobectomy on the other hand was easily tolerated. This second statement of ours has been frequently misquoted so frequently that we deemed it advisable to perform a new series of experiments to prove our conclusion that lobectomy in a dog is easy to perform and well tolerated and that the bronchial stump is closed by being firmly embedded in adhesions derived from peribronchial tissue.

The work here to be reported consists of 3 series of experiments.

1. A series of lobectomies carefully done with insufflation anesthesia the main bronchus being ligated to a lobe with silk or catgut the vessel to the same lobe ligated separately with silk or catgut and the lobe being amputated just distal to the ligature.

A series of lobectomies less carefully done both vessels and bronchi being ligated with the same mass ligature and an appreciable amount of tissue being left distal to the ligature. Open drop ether was used for the series.

3. One dog in which a careful complete one sided pneumectomy was performed.

SERIES 1 consisted of 7 dogs. Anesthesia was obtained by intratracheal ether insufflation. The chest cavity was entered by a intercostal incision. One or two lobes of the lung were exposed and delivered into the wound. With a small aneurysm needle the vessel to a lobe of the lung was ligated separately and the lobe was amputated. Only enough tissue was left distal to the ligature so that the ligatures would not slip. After the lobe was amputated the lungs were inflated and the wound as closed. In some instances the interspace was closed by proper mattress stitching. The catgut sutures in the muscles only were sutured. The blood was clotted by means of an antacuticular stitch and collodion.

Of these 7 dogs only 1 died from reopening of the bronchial stump. This dog died on the fifth day and presented the same findings as in our previous

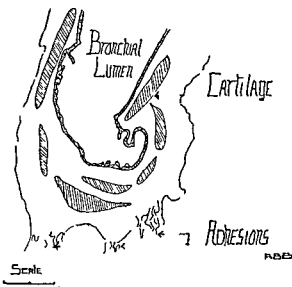


Fig 1 Camera lucida tracing from a typical case (Series 1, Dog 1) showing the dense adhesions which bury the stump. The stump is blunt. The mucosa has completely regenerated. The cartilage at the tip of the stump stains very faintly and is probably cartilage which was turned over by the crushing action of the ligature.

reports namely a clear pleural space, no emphysema, no free fluid in the pleural cavity, but a widely open bronchial stump. Death was sudden and due to internal pneumothorax.

One dog died on the fifth day, but to our surprise not only was the pleural cavity clear, but the bronchial stump was closed and the lung could be inflated with a syringe without any leakage of air. Careful autopsy showed no pathological conditions which might have caused death. The cause of death therefore was not determined.

The 5 remaining dogs all survived, were well, and were killed 23, 46, 53, and 60 days respectively after operation.

On examination the pleural cavities were found normal, no adhesions were present except in 1 dog in which a fine string-like adhesion rose from one of the lobes to the site of pleural incision. The pleural scar in all dogs was barely discernible. The lungs filled the pleural space. The bronchial stump was very difficult to find, the stump being buried in adhesions and usually covered by one of the remaining lobes of the lung.

In short in this series the majority of our dogs survived lobectomy, and the stump was found to have been buried in adhesions. Therefore we again maintain as do practically all other writers that dogs survive lobectomies and the closure of the bronchial stump is aided by connective tissue derived principally from the surrounding structures, adjacent lung lobes.

SERIES 2 consisted of 6 dogs. Lobectomy was performed by mass ligation and a larger (than in



Fig 2 The suture points to the bronchial stump of the amputated lobe deeply buried in adhesions.

Series 1) amount of ligated stump tissue was left. The operation consisted of an intercostal thoracotomy, a lobe being delivered through the wound, the hilus of the lobe being ligated, and the lobe being amputated in such a manner that a fairly large amount of lung tissue remained distal to the ligature. Four died from the reopening of the bronchial stump: 1 on the sixth day, 1 on the eleventh, and 1 on the eighteenth. The 2 other dogs who survived this period died of distemper: 1 on the twenty-first and 1 the fifty-fourth day.

The tissue distal to the ligature was thus deprived by ligation of the vessels of its blood supply and became necrotic. The necrotic tissue prevented the closing of the stump with the peribronchial tissue. We are aware that it is equally true that the necrotic tissue would have interfered with the healing of the bronchial tissues themselves, and therefore we are not advancing this as an argument to prove the nonhealing qualities of the tissues. We performed this series of experiments because we thought that the remaining pleura would be able to block off the bronchial stump even in the presence of necrosis, and that the pleura would be sufficiently resistant to cope with the small amount of infection.



TABLE I

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present. However in two third of our cases this was not found. We thought that perhaps on the other hand if the bronchial tissues did heal of their own accord we might have the stump lying free in a small walled off space.

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## SUMMARY

In our hands as in the hands of most experimenters lobectomy in dogs is an operation easily performed and well tolerated. The stump remains closed, the pleura does not become infected and the dogs themselves appear none the worse for the loss of the small amount of lung tissue. We think that the adjacent pleura and the peribronchial tissue play a major role in the closing of the stump.

In the first series lobectomy was done in 7 dogs—under intratracheal anaesthesia dissection of the main bronchus to the lobe and separate ligation of the blood vessel. Careful airtight closure was observed throughout. In this group 1 dog died from re-opening of the bronchial stump, one died on the fifth day but the stump was closed and buried in adhesions. Five dogs were killed 3, 46, 53, 53 and 60 days respectively after operation.

In the second series of experiments lobectomy was done in 6 dogs—mass ligation with an appreciable amount of tissue left distal to the ligation. Four dogs died from reopening of the bronchial stump, 5, 6, 11 and 18 days after operation. The other dog died of distemper 21 and 24 days after operation.

In the third series pneumectomy was done in one dog which died on the sixth day from re opening of the bronchial stump

## THE ANATOMICAL BASIS FOR THE STUDY OF SPLANCHNOPTOSIS

## THE ABDOMINAL WALLS AT TERM

By AGNES C VIETOR M.D. F.A.C.S. BOSTON  
F mth L b t y fth N w l kLy g l H p t l

OUR knowledge of the prenatal evolution of the abdominal walls is still incomplete. It is known that the viscera are developed first. Later these are surrounded by a membranous wall into which still later from the dorsal toward the ventral surface wander the muscles these latter carrying with them their nerves and some of their blood vessels (F. P. Mall). The viscera withdraw within the walls and take up certain positions within the abdominal cavity thus formed. The walls surround the viscera and follow them in their changes being more or less voluminous as the volume of the viscera is greater or less.

As the child develops within the uterus it retains more or less of its dorsal convexity the growing internal specialized parts (viscera) gradually becoming enclosed within the anterior concavity while the growing external specialized parts (upper and lower extremities) turn forward and fold up upon the walls—the whole forming an ovoid mass suspended in fluid the flexed head coming to be predominantly directed downward (Fig. 1).

As the child passes from this phase of existence its liquid surroundings disappear and as it is born it emerges unsupported by any close modifying medium into the wide ocean of the earth's atmosphere and directly subject to the laws there existing. It tends to fall in to a more or less horizontal plane spontaneously assuming a supine, prone or lateral position or some combination of these positions.

## THE ABDOMINAL WALLS AT TERM

When the child at term is laid upon a table in the supine position it tends spontaneously to assume a certain attitude i.e. the dorsal convexity tends to disappear and the spine tends to straighten the head falls to one or the other side in some degree of flexion and lateral rotation the upper extremities fall to the side of the trunk in some degree of

abduction the elbows are more or less flexed and the lower extremities assume an approach to the quadrupedal position the thighs being more or less flexed abducted and rotated outward while the knees are flexed so that the feet (heels) tend to approach each other in the median line (Fig. 2 a b g h i Fig. 3 a b e f g j compare with Fig. 2 c d e f).

Resistance is encountered if an attempt is made to change these positions to those assumed in the most advanced postnatal evolution of the individual i.e. head midway between flexion and extension so that the face lies in a plane parallel with the anterior plane of the trunk and lower extremities extended adducted and rotated inward so that the patellæ look forward. Resistance is also met in abduction of the arms beyond a right angle with the trunk. If these resistances are overcome the accomplishment of these later evolutionary positions is accompanied by changes in the trunk including especially the abdominal walls.

Therefore the study of the abdominal walls makes it necessary to study more or less the conformation of the child as a whole i.e. certain details of the spine thorax pelvis head and upper and lower extremities. This study is first made in the spontaneous position as already outlined while later are noted the modifications which accompany the marking of the advanced postnatal positions described.

## THE TRUNK AT TERM

*Shape of the trunk anterior posterior lateral and profile views.* In the supine position viewed from above the general shape of

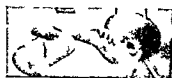


FIG. 1. Attempt to restore a child stillborn at term (9 \XII) to the intra uterine position p. profile view



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 t f t h l w t m t s e Ph t g r a p h f f m a l e  
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 h g f a l y t y p c l s p t p o t f t h l  
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 t h e s t l l b t t m b i Ph o t g r a p h f l  
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the trunk is bluntly fusiform and flattened more or less from before backward (in the early hours after death the abdomen is usually more or less rounded anteriorly as well as laterally) sometimes the central enlargement is prolonged upward and downward resulting in a barrel shaped figure sometimes the lower pole of the spindle is enlarged laterally giving a square or rectangular shape to the lower trunk. The lower pole of the spindle appears to be bounded in front by the suprapubic groove and the trunk appears to terminate in a waist which is marked anteriorly by this line and laterally by the apex of the trunk thigh lateral angle (Fig 2 b g Fig 3 a e f)

The upper limits of the trunk are obscured and made to appear square or rectangular by the shoulder girdle and the muscles connecting the trunk with this girdle. When the shoulder girdle is removed the true shape of the upper pole of the trunk is seen and the upper pole of the spindle is seen to be the smaller (Fig 3 d compare with c e)

Viewed from the side the front profile of the trunk (Fig 3 f to j) shows an anterior curve which is markedly ovoidal the convexity of the curve rapidly increasing from the sternal notch downward to reach its maximum in the neighborhood of the lower end of the gladiolus or the upper epigastric region. From here the curve as a whole rapidly decreases as it passes downward to the symphysis though sometimes it is broken by a slight secondary convexity near the umbilicus. In this position the child appears to rest upon the table in an unbroken line from occiput to buttocks the lateral walls of the abdomen tending to project more or less laterad and dorsad obscuring line of spine

In the prone position viewed from above (Fig 4 a b) the entire back appears square or rectangular narrowing downward as to a waist at or just below the crests of the ilia at the trunk thigh lateral angle. This apparent waist line marks the lower pole of the spindle and is continued anteriorly by the suprapubic groove. It is also marked medially by a more or less pronounced receding angle opening dorsad (lumbosacral angle) with more or less irregular transverse surface grooving. The lower pole of the trunk posteriorly (lo s) is materially broadened or narrowed by the presence or absence of a pyramidal mass of fat which fills Petit's triangle and extends down over the upper part of the ilia to join the general increase of fat from there downward over the buttocks (Fig 4 b)

As in the supine position the upper limits of the trunk are obscured and made to appear square or rectangular by the shoulder girdle and the muscles connecting the trunk with this girdle. When the latter is removed the true shape of the upper pole of the trunk is seen and the upper pole of the spindle is seen to be the smaller (Fig 4 c)

Viewed from the side the back profile (Fig 4 d e) shows a long oblique line or a long very slight curve with convexity dorsad. In either case the line is limited by two slightly receding angles with apices directed ventrad the upper angle being at the junction of the head with the trunk and the lower a little below the crests of the ilia (lumbosacral angle). Caudal to this latter angle the continuing line rather brusquely becomes quite convex because of the rounding dorsad of the buttocks. In this prone position the front of the trunk rests on the table in an unbroken line from point on sternum below the notch where the bone falls into contact with supporting surface.

It is difficult to place the trunk in the lateral position its tendency being to fall more directly prone or supine according to the position and weight of the shoulder and pelvic girdles and according to the position of the upper and lower extremities which enter into the supporting base.

The tendency is more toward the prone position because of the tendency of the arm to fall forward and make traction in the same direction on the scapula and upper trunk. When the forearm is extended and the whole upper extremity placed directly on the side of the trunk the latter seems to incline a trifle toward the supine position on account of the weight of the scapula and its attachments.

When the trunk is balanced as well as possible midway between pronation and supination and viewed from above the anterior outline (front profile) of the trunk appears ovoidal the longer arm of the curve being cephalad and extending from the neighborhood of the sternal notch to about the level of the ninth rib in the midaxillary line from this point the curve may maintain its maximum or even slightly increase for a short distance then it rather rapidly decreases to the symphysis pubis.

The posterior outline (back profile) may appear straight or it may show a slight posterior convexity extending from the base of the cranium to the end of the buttocks this curve being broken at about the level of the crests of the ilia by a slight receding angle with its convexity anterior (lumbosacral angle). This receding angle varies in size with the degree of extension of the thighs upon the trunk. When the thighs are well flexed this angle practically disappears and the straight line or posterior convexity of the spine may appear to be continuous. The posterior line may be modified by variations in the balance of the trunk.

**Trunk markings** Viewed from the front the salient trunk markings are the trunk thigh lateral angle the suprapubic groove the groin grooves secondary transverse grooves variable muscle markings variable periumbilical fat cushions an occasional ensiform depression and an occasional costal margin groove (Fig 2 b g h i compare with c d Fig 3 a b d e)

The downward tapering of the trunk ends laterally at or just below the crests of the ilia. Here an obtuse angle opening upward and perhaps also more or less forward is formed by the junction of the trunk and the thigh. The apex of this trunk thigh lateral angle (which may be more or less blunted) is usually situated at about the level of the

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 l m l t h p t t h g h l t h b u t t c k  
 l t c e l g l h r a l l y (I g 4)

**Longitudinal trunk planes** The trunk is bounded by four longitudinal planes anterior posterior and two lateral. On dissecting away the skin superficial fascia and all the muscle covering the spine and ribs but leaving intact the abdominal muscles (including the quadratus lumborum) leaving also the ligaments and articulations intact and then removing the shoulder girdle these planes are seen more distinctly.

The anterior plane (supine position) consists above of the sternum and the sternal cartilages. It is bounded laterally by the junction of the ribs with the sternal cartilage and broadens from above downward. It is distinctly marked down to about the eighth rib; it is less distinct at the ninth rib and below that it cannot be clearly distinguished from the lateral planes into which it merges (Fig 3 d e h i).

l l t p l l d c t d d n d d f a r d t  
 b o t l l l f t h t h d f t h b f m t h p o t  
 t h f l d t l t l m k d b t t t s  
 l l d t b o t h l l o f t h l e d f t h e  
 l l l t f t h p l m y t h e c h g e t s l b l  
 d d l b c k w d t m y t t e t h e s m  
 l h t l t f r w d d t d t o b o t  
 t h l l f t h t h c s t l t l g w h t j t h  
 t l m g u d t h d c e g d l l y t h t h g h b o  
 h o o d f t h u m b l s d p d g t h l m e d  
 m t f d t t o f t h d r l y c  
 f m t h m b l u o p h p s a b o e t h p o t t  
 l b k w d d d w d m o l e r p d l y d  
 l l g t h o l m d m o t f d t t o f t h  
 d e l y h  
 d e l y h d y b d t h e q e a p p e r a f t h  
 p p p t f t h t k s d e t t c n e c t t h t h  
 p p e t m t b y t h p e c t o l m l n d t h s c p u l  
 h h f m b d h t l y a d p o t l y t h b d  
 l g f m t h p p e p o t f t h t r u k p l  
 w h h e w b l (F 3 F g h)

The posterior plane (prone position) broadens from above downward until it reaches its maximum at about the level of the apex of the twelfth rib; its breadth then decreases slightly to the neighborhood of the crest of the ilium. More and more from above downward in the prone position the broadening of this plane is due to the ribs anterior to the posterior angle entering into this plane (Fig 4 b c e).





TABLE II b—FETAL CASES TRUNK MEASUREMENTS VERTEX HEIGHTS AND FRACTIONAL TRUNK HEIGHTS ANTEROPOSTERIOR AND TRANSVERSE DIAMETERS GIRTHS

F t l C	A							
	t 6 m				5 x 1			
W ght (gm)	7	11	6	XX	6	XX	6	XX
H ght (mm)	65	545	95	585	693	3	5	1
V t	45	38	36	3	8	35	6	74
St l t h	3	4	55	3	7	34	6	9
Gl d l	59	87	94	98	6	67		97
N th t l t l g	5	63	94	69	75	3	48	81
Umb l	7	4	68	54	54	6	3	7
Il ac est (m d l)	8	4	6	44	49	4	4	
Symph p b	78		4		8	3	3	59
T k d m t (mm)								
L l t l t h								
A t p t or	5	36	39	7	34		7	
Sh ld								
T ns	3	7	94	8	8	6	45	4
Thrd pac								
Ant p t	63	45	49	4	45		39	
T	7	47	6	54	54	3	45	
Gl d l								
A t post	68	47	5	43	47		43	
T	84	50	7	6	61		5	
N th b (m d l)								
A t po t	68	45	5	4	46	3	47	
T	94	57	8	66	68		57	
N th tal t lag								
A t po t	65	4	5	38	41	6	46	
T	9	56	83	67	65	6	58	
Umb l								
A t po t	58	34	41	34	37		45	
T	8	48	75	50	59	6	45	
Il ac t (m d l)								
Ant po t	58	34	43	33	36	6	35	
T	8	49	69	53	57		45	
W lth bc t l gl t th t l t l g	8	4	79	6	6	6	5	
G th (mm)								
Cl d l	55	68	5	76	96	3	5	
N th b (m d l)	6	69	9	79	9		53	
N th t l t l g	5	59	9	75	84	3	5	
Umb l	5	4	5	94	7	3	3	

corresponds with the conjoined shape of the viscera which it contains and its increase and diminution correspond with the increase and diminution in volume of these viscera—the bases of the lungs the diaphragm the right and the left lobes of the liver the stomach spleen pancreas duodenum jejunum ileum transverse colon splenic flexure and upper part of the descending colon probably the adrenals and perhaps the upper portion of the left kidney (Fig 3 a to e)

This division is predominantly ellipsoidal swelling out laterally in the midaxillary line from the st. th. to the tenth ribs the maximum being from the seventh to the ninth or tenth ribs. There is also a more or less marked anterior rounding which having begun in division 1 at about the level of the third or fourth rib continues downward in this division to about the level of the ninth costal cartilage (Fig 3 b to j). There is moderate variation in the form of this division depending on variations in the size of the liver and in the volume and amount of distention of the stomach and intestines.

Division 3—from about the level of the ninth costal cartilage at the costal margin to the suprapubic groove in front and to a little below the crest of the ilium laterally. The shape of this division corresponds with the size and volume of its contained viscera—

jejunum ileum ascending colon caecum lower descending colon sigmoid colon perhaps sometimes the adrenals usually the greater portions of the kidneys the bladder fundus uteri and ovaries and perhaps redundant transverse ascending or descending colons (Fig 3 a to e Fig 4 a to c Fig 2 g h)

This division is predominantly a section of an ovoid but at the sides it always tends more or less to overhang the crest of the ilium. There is a fair amount of variation in the form of this division on making toward a square or rectangular effect depending upon the volume and amount of distention of the intestines particularly the sigmoid colon and also upon the amount of subcutaneous adipose tissue. It rounds out anteriorly rather than laterally any redundancy of its contents tending to travel forward rather than laterally or backward (Fig 3 f to j). However after a certain anterior limit is reached it then rounds out laterally becoming more square or rectangular and overhanging its lower boundaries.

Predominantly then the trunk appears to consist of a truncated quadrilateral pyramid (division 1) blending at its base with a section of a more or less flattened ovoid (divisions 2 and 3) the latter tapering downward to the top of the symphysis pubis in front (suprapubic groove) and to a little below the crests of the ilia laterally. Occasionally the ovoid





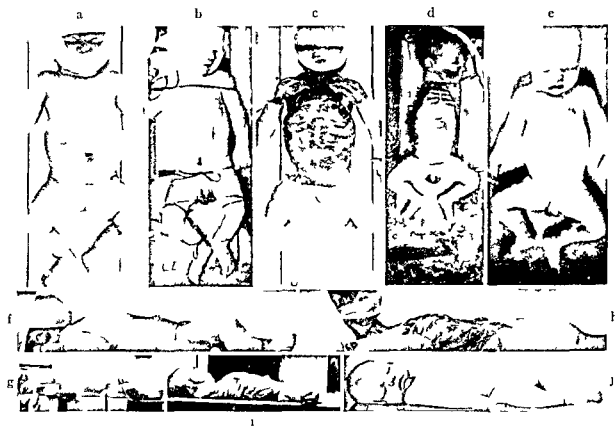


FIG. 3. a b Shape of the trunk at term in the supine position anterior view seen from above (9 LIX 9 LXVI) c Another subject (9 LXXIII) same position and view as in a and b with the skin and superficial fascia removed from the trunk shoulders and neck d Another subject (9 LXXIV) similar to 3 c but with the shoulder girdle and some of the external muscles removed

e Another subject (9 LIX) showing outline of 3 d with the shoulder girdle in place f Same subject as in 3 a (9 LIX) but profile view front and back profiles of the trunk in the supine position g Same subject as in 3 b same view as in 3 f h Same subject as in 3 c profile view i Same subject as in 3 d profile view j Same subject as in 3 e (9 LIX) profile view

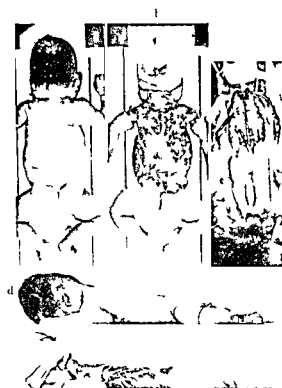
hood of 90 degrees sometimes less (45 60 degrees etc) sometimes more

The leg and foot follow the thigh in its outward rotation so that they tend to rest on their outer surfaces the calf is broad and the crest of the tibia looks forward and outward and more or less downward the feet lying on the outer border or even partly on the dorsum The flexion of the knees carries the feet toward the middle line of the body the soles looking more or less medially The heels approximate and the feet diverge downward and outward sometimes also forward from the heel Sometimes the two soles approximate throughout their length Sometimes the feet lie one crossed above the other one sole as if clasping the opposite tibia

This position of flexion abduction and outward rotation which the lower extremities spontaneously assume is the remnant of older biologic positions which are now and

which have been throughout prenatal life in transition toward the human type postnatal position of extension adduction and inward rotation so that the patella and feet look forward (Compare with Fig 2 c and d)

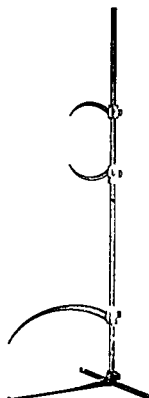
The feet tend toward supination the soles looking a little upward sometimes markedly so The heels are small and pointed and covered with a fat cushion the ball of the foot is broad and unless obscured by fat cushions the longitudinal and transverse (anterior) arches are definite The instep is broad but the ball and toes are still broader The toes lie side by side not encroaching upon each other the great toe tending to be more markedly separate from its adjacent neighbor (Fig 6 to 1 Fig 3 j Fig 4 e) The toes are usually slightly flexed especially the middle and distal phalanges Sometimes to flexion of the middle and terminal phalanges is added extension of the first or proximal



1 4 S m l j t I k 3 t l j t  
 t p t f m l 4 t l k l l k  
 t l f 3 m l f m t l k h l l k  
 N t l m l f t h p y m l l f f t (p  
 l f m t h l f t t t l 3 t h t d  
 f t h l p l f t l k l t h t d  
 Th t d f t h h t l f m t h t l S m  
 l y t l p l m t f t l f t y p l k h t l  
 l j t F 3 d m 4 b t h t h l d  
 g l l d t l d p t l y d t h t l m l  
 m d N t t h f t h p t t p l l  
 t h f d l t f t l d t t d l t l l  
 l l p d l l t f f t h l f m d  
 f r y d l d k f t h s p l d S m b j t  
 b t p l l f t d b k p l l f t t k t h  
 p p t S m b j t 4 b p t l w  
 Th d g f p t d t h l f t h l k  
 t d l h b t d m t d l y l k h t  
 t m t t l l d m t t l p p m t  
 t h t b d f t h l f t h f t t h l  
 t w h h m t m m d p t l f k  
 b k

The longitudinal arch is reflected upon the dorsum of the foot which toward the inner half is elevated proportionately the dorsum falling toward the outer half as the arch disappears and the sole descends to the plane of the heel and forefoot.

When the anterior arch is marked the first phalanx continue the distally declining



I k c l l f m f t l t u k h h t  
 3 t r u k l m t l k t g h t l d e d b y t h  
 t l d l l l y c l t m a c \ Y k  
 2 4

oblique line of the dorsum of the foot and continue the line of the metatarsal gradually moving toward the plantar flexion of the more distal phalanx (Fig 2 h—left foot 1—both feet Fig 3 b—both feet d—right foot f—right foot g—right foot). When the anterior arch is marked the distally declining oblique line of the dorsum of the foot is broken at the metatarsophalangeal junction by an angle opening dorsally the first phalanx moving toward dorsal flexion with lowering of their proximal end. The distal ends of these first phalanges thus project upward and the palmar flexion of the more distal phalanx continuing the appearance of claw or hammer toes is thus produced (Fig b—left foot g—both feet h—right foot Fig 3 a—right foot). This variability suggests that the anterior arch is not definitely fixed at term and that it depends upon free

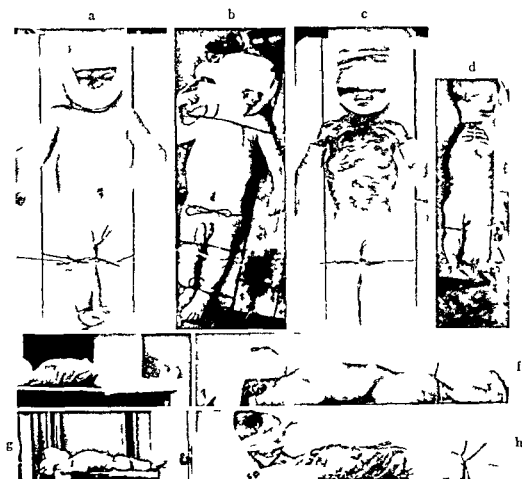
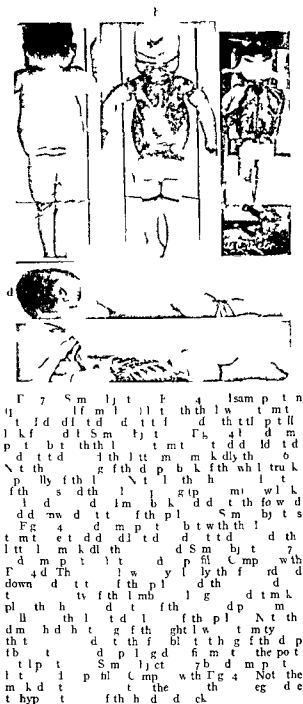


Figure 6 a Same subject as in Figure 3 a and same position but with the lower extremities extended adducted and rotated inward so that the patella look forward. Note the strong action toward adduction and supination of the feet due to extension of the thighs and knees. The thigh is tied in a slightly exaggerated inward rotation to counteract the strong pull of the deep fibrous tissues toward flexion abduction and outward rotation. Note the greater firmness of the contracted fibrous tissues in the right extremity causing shortening of that extremity from persisting flexion at the hip and knee. b Same subject as in Figure 3 b and same position but with the lower extremities extended adducted and rotated inward so that the patella look forward all of these changes being less complete than in 6 a. Note the beginning interference of the forepart of the feet with each other both as the extremities bend about the same length. c Same subject as in Figure 3 c and same position but with the lower extremities extended adducted and rotated inward so that the patella look forward. Note the narrowing of the trunk from side to side and the descent of the symphysis. d Same subject as in Figure 3 d and same position but with the lower extremities extended adducted and rotated inward so that the patella look forward. Note the sharp flattening of the lateral planes as

they pass backward from their junction with the anterior plane. e Same subject as in Figure 3 e and same position but with the lower extremities extended adducted and rotated inward so that the patella look forward. Note the forward and downward rotation of the pelvis the forward change of the lumbosacral region (posterior abdominal wall) the forward projection of the anterior wall of the whole trunk the upward and forward rotation of the thoracic cage and the lengthening of the abdominal ante only. f Same subject as in 6 a and same position but viewed in profile. Compare with Figure 3 f. The forward arching of the lumbosacral region is shown more clearly than in the preceding case. g Same subject as in 6 b and same position but viewed in profile. Compare with Figure 3 g. The tension of the lower extremities has relaxed somewhat allowing the firm fibrous tissues to draw the extremities toward their former outward rotation as shown in the profile and feet. h Same subject as in 6 c and same position but viewed in profile. Compare with Figure 3 h. As in the preceding case the tension has relaxed somewhat and the continual action of the deep fibrous tissues has drawn the right lower extremity toward its former outward rotation as shown in the position of the patella and foot.

plantar flexion of the metatarsophalangeal articulations and the preservation of the grasping powers of the whole forefoot (Figure 2 c) compare with subhuman forms—Figure 2 c d e f).

The inner border of the foot forms a very obtuse angle opening inward (medial) and a little forward at about the level of the scaphoid or a little anterior to this bone. The first metatarsal bone and the great toe form



the anterior arm of this angle this anterior arm extending forward and still farther medially. The outer border of the foot forms a very obtuse angle opening outward at about the level of the cuboid. The fifth metatarsal bone and the fifth toe form the anterior arm

of this angle this anterior arm extending forward and still farther outward (Fig 1 b g Fig 3 f g j Fig 4 c d Compare with Fig 2 c for a subhuman foot showing similar angles d e f for a subhuman foot showing diminution or absence of these angles and h i for a human foot at term showing almost complete obliteration of the internal angle of the right foot under pronation)

The femur is curved from without inward and from before backward the convexity looking forward and outward and being on what becomes the anterior surface when the bone is rotated so that the patella looks forward this surface now being directed forward and outward

The bones of the leg are curved concave inward and forward the concavity being on what becomes the internal surface when the thigh is rotated so that the patella looks forward this surface now being directed inward and forward the curve being more marked in the tibia than in the fibula. This curved line continues downward to the sole where the heel tend to merge into the beginning of the arch the line being broken only by the slight prominence of the internal malleolus

I th p t f th l g l ft d f m th t bl th foot  
h l ely t th kl d th w ht f th foot  
t t g t d th t d f th l g th nt l  
m ll l t b l g d th fo t t d t f l l t lly  
t d ht l tl th l g d th p t f d f  
the nkl t doopl th the h l

*Changes in the lower extremities and modifications of the body form occurring at term as the advanced postnatal position of the lower extremities is developed* If one attempts to place the flexed abducted and outwardly rotated lower extremities in the postnatal position of extension adduction and inward rotation so that the patellae look forward resistance is met. If this resistance is disregarded it is found that the postnatal position can be attained only by compensatory changes in the pelvis abdomen spine and thorax as well as by direct changes in the lower extremities themselves (thigh leg and foot). Summarized these changes may be grouped as follows (Figs 6 and 7 compare with Figs 3 and 4)

1 The trunk thigh lateral angle increase toward practical disappearance and the lateral pelvic region becomes defined between the

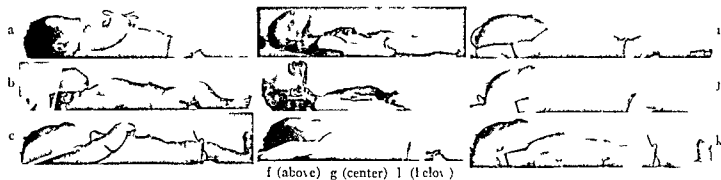
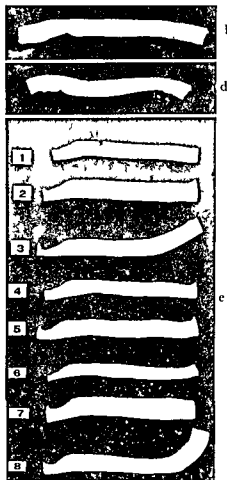


Fig. 8 The spinal curves at term. a Same subject and same position as in 11 u e 3 f but with the head in spontaneous flexion and with the arm drawn forward enough to show the apparent absence of anteroposterior spinal curve in the supine position at term. b Same subject and same position as in 8 a but with the head held in extension so that the face is in the frontal plane. c In a plane parallel with that upon which the trunk rests. d Same subject and same position as in 8 b but with the lower extremities extended adducted and rotated inward and with the arm drawn forward as in 8 a. e Posterior line of the spine in the undissected subject. supine position viewed from the right. Note only the lower line of these two casts. f Plaster cast showing along its lower edge the posterior line of the spine and lower occiput in 8 b. g Plaster cast showing along its lower edge the posterior line of the spine and lower occiput in 8 c. h Anterior line of the spine after removal of all the viscera. supine position viewed from the left. Note only the upper line of all these casts. i to 6 (9 LI) 7 8 (9 LII) 1 7 Plaster cast showing along its upper edge the anterior line of the spine when the head is flexed so that it rests on the lower part of the occipital protuberance (a trifle more flexion than in figure 11 a compare with Fig. 11 b). 6 Head flexed so that the face lies in a plane which makes an angle of about 45 degrees with the horizontal plane upon which the trunk rests (Fig. 11 a). 3 8 Head extended so that the face lies in the frontal plane. i e in a plane parallel to that upon which the trunk rests a trifle more extension than in figure 11 d. 4 5 Same extended position of the head as in 3 but the occiput is allowed to seek its support (23 and 35 millimeters respectively) below the horizontal plane upon which the trunk rests till the articular base of the occiput is in line with the straight cervical spine the latter resting on the same horizontal support as the trunk (Fig. 11 g h i). f (9 LIII) g (9 LIV) Development of a cervical anterior or convex curve by both flexion and extension of the head when the backward and downward excursion of the occiput is restrained by its resting upon the same horizontal plane as that upon which the trunk rests. Upward and forward rotation of the thoracic cage upon a transverse axis caused by raising the arms so that the humerus approaches the side of the head. Same subject as in 8 a. h Same position as in a but with the arms raised to the side of the head without forcible extension of the elbow. i Same as h but with the humerus tied in position and with the elbow tied in extension. j Same as i but with the head supported in extension so that the face lies in the frontal plane. k Same as j but with the lower extremities held in extension adduction and inward rotation.



crest of the ilium and the trochanter the outer surface of the great trochanter looks backward and outward instead of backward and a depression forms behind it while the buttocks narrow and fall. The whole trunk narrows from side to side (especially the loins) and appears to elongate. Modeling of the trunk thighs legs and feet develops.

The anterior internal and external surfaces of the thighs become tense and depressions appear in front of behind and below the trochanter while a depressed longitudinal band of tension extends down the

outer surface of the thigh toward the knee. The adductor region is thrown into oblique grooves running downward inward and backward. The tension in the thighs is conveyed over the patella and around it on both sides to the legs (more marked on the inner sides) which now describe a slight curve with the concavity medially. There is added strong tension down the back of the thighs and legs to the heels.

The tension in the legs is conveyed over the dorsum and sides of the feet which now continue the curved line of the legs and tend to



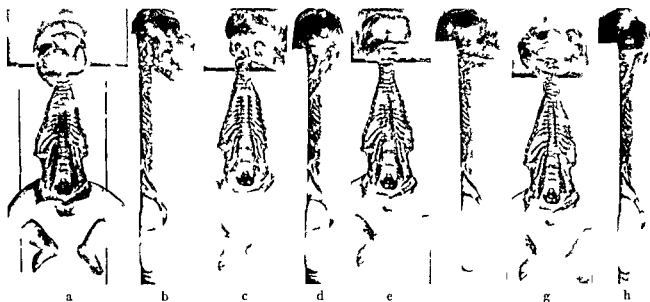


FIG. 10 The straight cervical spine a to h. Same subject and same positions as in Figure 9 except that the occiput is unrestrained in both flexion and extension of the head and is allowed to seek its normal positions dorsad to the straight cervical spine coming to rest on a horizontal

The pelvis no longer looks like the upward expansion of the lower extremities united with the trunk at the trunk thigh lateral angle. It now appears like the lower portion of the trunk of which latter the lower extremities appear to be direct downward continuations. It lies more obliquely between the trunk and the lower extremities the latter now lying in a plane the long axis of which continues the long axis of the trunk. As a result of this changed position the viscera no longer rest so completely upon the broader back and within the upper pelvis but are thrown forward and downward causing increased stress on the anterior and anterolateral walls which are lengthened by the descent of the symphysis (Fig 6 compare with Fig 3) while the back appears shortened by the increased lumbosacral angulation (Fig 7 compare with Fig 4).

4 In proportion as the tension from the anterior convexity of the lumbosacral region extends upward into the thoracic region the thoracic cage tends to be rotated upward and forward again causing lengthening of the abdomen anteriorly.

These changes in body form cause some variations in the trunk measurements. Attempts were made to resolve these complex changes into their simpler elements so note

plane which is lower (dorsad) than that upon which the trunk rests but parallel to it. Note the absence of the cervical lateral curvature when the head is rotated to one or the other side though the lateral deviation appears but to a less extent.

was made of the details observed when in its spontaneous position no change was made except to rotate the thigh inward or to adduct it or to extend it or to extend the knee in the varying positions of the thigh.

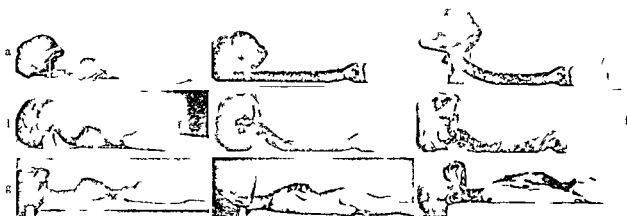
Thus inward rotation of the thigh can be accomplished as an isolated action when the thigh is left in its original flexion and adduction (b). But adduction of the thighs so that the knees approach each other and the patella look forward cannot be accomplished as an isolated action; this movement being always accompanied synchronously by inward (forward) rotation (c). The thighs can be adducted with a minimum of inward rotation if the knees are allowed to overlap the flexion of the overlapping thigh being then increased.

Extension of the thigh on the pelvis can be accomplished in both the abducted (d) and adducted (e) positions; this action always being accompanied by less (d) or more (e) for inward and outward rotation of the pelvis upon a transverse axis and by a beginning extension of the leg at the knee—this latter movement extending to the foot and in its most complete form causing an inward rotation of the leg and foot with supination and adduction and with overlapping of the forepart of the feet.

Extension of the leg on the thigh can be accomplished in both the abducted (a) and adducted (f) positions of the thigh and in both positions the action is conveyed upward to the thigh and pelvis and downward to the leg and foot. A flexing the thigh flexed abducted and rotated outward and making no change in the original spontaneous position except to extend the leg on the thigh at the knee.

Tension and rigidity develop in the popliteal space along the posterior internal thigh along the antero-internal thigh to below the symphysis pubis and along the tendo Achillis. The resistance offered can apparently be overcome only by making tension and stretching the hamstring tendons especially the internal going to the tibia and to a lesser extent the adductor mass.





by the relatively great breadth of the latter and by the apposition and tendency of the feet to overlap

d Restoring the original position on and making no change except to extend the thighs on the pelvis letting the legs fall over the edge of the table

Tension develops throughout the length of the thigh. The pelvis rotates forward and downward with arching forward of the lumbar spine and lifting forward off the table of the posterior loins. This action is more pronounced when extension of the leg precedes that of the thigh. The arching of the trunk is about one third as much as when adduction and forward rotation of the thighs are added.

Tension from the thigh is conveyed over the patella and around it on both sides to the leg causing springing forward of the leg in slight extension (similar to the patella reflex response) with increased tension over the front and sides of the leg and suggestion of the same tension even posteriorly although the same over the dorsum and sides of the foot.

e Combination c and d—adducting and rotating forward the thighs and then extending the thighs on the pelvis but leaving the knees flexed by letting the legs fall over the edge of the table all the preceding phenomena develop in a more definite form.

The pelvis is at once rotated forward and downward on a transverse axis the lumbar spine and loins following it. Tension develops over the anterior internal and external surfaces of the thighs with deepening and broadening of the external longitudinal shallow groove the tension extends upward to the trochanter to the anterior superior spine and to below the crest of the ilium also along the trunk fascia especially laterally between the crest of the ilium and the ribs and through the abdominal wall strong tension is felt along the psoas iliacus. The lower thoracic spine follows the forward arching of the lumbar spine with rotation upward and forward of the thoracic cage causing lengthening of the distance between the gladiolus and the symphysis pubis with rounded prominence and increased tension of the whole anterior abdominal wall.

When the movement of the upper trunk is inhibited (as by its stability or by holding it) tension in the posterior loins is increased when there is lessened resistance in the upper trunk the posterior arching is increased and diffused cephalad as above the upper trunk slides downward as the thoracic cage arches forward and upward.

The tension in the thighs is conveyed over the patella and around it on both sides to the legs and feet as described in d but more markedly. The foot continues the line of the leg which describes a slight curve the concavity being directed medially.

f Adding e tension of the knees to the preceding adduction forward rotation and e tension of the thighs all the preceding lines of tension and movement are increased in intensity as already described in the advanced postnatal position of the lower extremities.

The longitudinal groove lengthens and becomes more strongly marked sometimes it tends to become oblique from the neighborhood of the anterior superior spine towards the head of the femur. There is added strong tension down the back of the thigh and leg to the heel also down both sides of the tibia more marked on the inner side and causing slight movement toward flexion and supination of the foot which is held firmly in the continuation of the curved line of the leg already caused by adduction and inward rotation of the thighs so that the most distal portions of the feet are directed the most internal and the frontal portions of the feet tend to overlap.

When this overlapping is prevented and the heel are kept approximated there occurs a proportionate amount of abduction with eversion of the feet. This can be com-

pensated for by increased inward rotation of the thighs separating the heels and abducting them allowing the frontal portions of the feet to curve inward.

The tension along the legs is not only increased but the feet are carried more firmly inward at the malleoli and the forward part of the feet tend more decidedly to overlap. If this overlapping is prevented whichever foot presses the more strongly forces the other into corresponding outward rotation (pronation abduction with slight eversion).

Bowing of the legs exists even when adduction and forward rotation are complete because of the curviness of the bones of the leg in internal concavity. When adduction and inward rotation are incomplete the bowing is continued upward to the thigh though sometimes broken by the inward projection at the knees (Fig. 6 b Fig. 7 c). A condition of knock knees is produced or favored when the legs do not follow the thighs in adduction this failure being favored by incomplete locking of the knee joint due to incomplete extension of the leg on the thigh (Fig. 6 a Fig. 7 b).

#### THE ANATOMICAL PATHS ALONG WHICH THE POSTNATAL BODY FORM IS DEVELOPED FROM THE BODY FORM AT TERM

As all the muscles in the dead body are lax and non contractile all the shapes positions actions and movements described must be due (aside from the mechanical presence of the muscle masses the fat masses and the viscera) to the arrangement and connections of the firm fibrous tissues. These tissues are the bones ligaments around and within the bony articulations the deep fasciae intermuscular septa muscle sheaths tendons and aponeuroses and to some degree the superficial fascia and the skin. Nerve sheaths are shown to be very important so are arteries and veins which run a straight course while vessels which run a tortuous course can as a rule be disregarded probably because the tortuous course does not convey tension as does the straight course. All these tissues must in the light of the experiments here made be considered as being the more fixed and conservative factors in determining and preserving the body form. The position spontaneously assumed by the child at term is due to relative shortness of the firm fibrous tissues along lines made strong by older biologic paths and this explains the anatomical difficulties which beset the struggle toward the biologically more recent human type and the tendency of the latter to spontaneously revert toward details of the earlier prenatal type.

Hence modifications of the body form are essentially due to modifications of these fibrous tissues. And the postnatal changes in the body form are essentially due to certain definite stretchings and tractions of the fibrous tissues (plus contour and other modifications due to positions and conditions of the viscera and to muscle and fat masses) and to the activity of the muscles these latter being the agents which are continually antagonizing the innate tendency of the fibrous tissues to return toward their earlier relations. In other word the instinct toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscle (as well as the viscera) the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissue (as well as the viscera). And whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly movement then being in the direction of reversion toward earlier (prenatal) forms.

th p bl m t t l t t l th  
f d m t l t m b th t t b j t t  
th m l f y g t f m th t l l w l  
f h h t f l t h p t

Attempting at term to trace the anatomical paths and relations along and through which these fibrous tissue act one note that on discontinuing the external force necessary to change the lower extremities from their spontaneous position of flexion abduction and outward rotation to the postnatal position of extension adduction and inward rotation both the thighs and the legs tend to return to their former spontaneous position this return being diminished in proportion as the tissues have been stretched beyond certain limits

th m t t t t l t m k f l d l t  
m y t th l m e s f th h b t D t l  
f m f th l l t th f th l  
t m t f th l l dy t l m k p th m  
m t f l l h h t l t m k f d  
l l l l d l l N th l f l  
h bod f m l l h l m t l f l  
l th m f l t h t

*Skin and superficial fascia* The relation of the skin and superficial fascia to details of the

body form is shown in the surface markings and in the modifications of these markings which appear with changes of positions and upon removal of these tissues in the laxity and change of contour seen in those muscles which have no or only thin fibrous coverings

*Deep fibrous tissues nerves blood vessels pelvis thigh angle pelvis spine union* After the removal of the skin and superficial fascia the deep fibrous tissues are exposed and their traction and stretching and overstretching may be observed directly. One may see these tissue stretch grow tense grow rigid the arteries elongate and flatten the blood become pressed out from the stretched and collapsing veins the nerve trunks grow taut the fibrous planes develop pale thin and flaccid areas and finally shred into solution of continuity according to the degree of antagonizing external force applied

Th t d t l p d p t l f b  
t t y m d t l t m t f m th at t m  
t l t p t l p t h w th t h p tal p o t  
t l t h t t t f t d p f b  
t (t m t f l b l m l p t f t  
l l th f t l p t l d th gh st t ch  
l l n g h t f th h b t th def t  
t t f l t y p th h m typ  
Th p l f th t h n l gh g t b l  
l th p f t h n b t l t l f m k d b y  
l g n t t t f l dy f m th  
p t l l t f th h m t p e t h e s b t l  
m l th d l y l t f th t y p s m d  
l th m p t f t dy th t m l path  
l wh h th l t p d d th b t l wh h  
m p d t p g t h m l f th b t l w l l  
l t d l th h p t th p t l l l f t l  
a j

Incisions were made across the fibrous tissue which offered resistance to the development of the postnatal position of the lower extremities. The results of the incisions justify the following deductions

1 Flexion abduction and outward rotation of the lower extremities are due to shortening of the deep fibrous tissues of the anterior internal and external regions of the thigh and to some extent of those of the posterior part of the thigh including those of the great sciatic nerve and also the connections of these fibrous tissue with the hip joint the pelvis and the lumbar spine

2 Adduction and outward rotation of the thigh depend not only on the relative shortness of the fibrous tissues already enumerated

but also on the formation of the capsule of the hip joint and its spontaneous tendency to untwist and assume a direction favoring outward rotation of the femur with abduction.

3 Adduction and forward rotation of the thigh in the plane of the spontaneous flexion present lock the hip joint and make the pelvis and femur practically one bone bent at an angle opening forward and united by the shortened and thickened capsule. The size of the angle depends on the degree of spontaneous flexion present. As a result of the development of this pelvic thigh bone backward movement of its lower end (extension of the thigh) causes forward movement of its upper end (forward rotation of the pelvis). Associated forward passing of the lumbar and lumbosacral spine follows according to the firmness of connection of the pelvis with these vertebrae. But while the upper lumbar vertebrae are progressively freed from the forward pull of the (pelvic) fifth lumbar vertebra they continue to be pulled in the same anterior direction by their direct attachment to the upper end of the femur through the psoas iliacus muscle. When the pelvic thigh connection is established the only movements possible in the hip joint are a certain amount of abduction and a very slight increase in adduction. Weakness of the locking of the hip joint probably enters first through abduction since that is less opposed than adduction.

4 Extension of the thigh favors extension of the knee the impulse being conveyed down the leg to the foot.

5 Adduction and supination of the feet are directly related to extension adduction and forward rotation of the thigh and extension of the knee by the deep fibrous tissues. When the knee is not fully extended locking of the foot in adduction and supination is diminished abduction and pronation are favored and these movements of the foot may lead to outward rotation of the leg and thigh with or without torsion of the knee from within outward with prominence of the internal condyle of the femur.

6 Extension adduction and forward rotation of the thigh must be accomplished by some active force not present in the dead

body. Since there is no tissue which acts spontaneously and continuously in the direction of extension adduction and forward rotation as the fibrous tissue does in the direction of flexion abduction and outward rotation whenever the active counteracting but intermittent force (muscle) relaxes the former tendency asserts itself and draws the thigh towards flexion abduction and outward rotation.

Dissections Group a Thigh hip joint pelvis lumbosacral spine thoracic cage

a1 Incision in the upper portion of the thigh and blunt dissection to expose the capsule of the hip joint thorough incision of the capsule including both limbs of the Y ligament. Then adducting rotating inward and fully extending the thigh the head of the femur protrudes beyond the limit of the capsule.

The lumbar spine the loins and the pelvis still move forward on extension of the thigh though less extensively and with less force. All of the muscles of the anterior and anterolateral parts of the thigh are made tense by the extension especially the tensor vaginae and the sartorius but also the rectus and also the adductor region (gracilis?).

Extension also causes grooving of the surface of the thigh diagonally upward from the outer side of the knee to over the tensor vaginae. A second groove or depression appears in front of and below the trochanter.

a2 As the skin and superficial fascia are removed one notes that there is some relaxation of the deeper tissues. The adductor mass on the inner and posterior sides of the thigh not being confined by the deep fascia falls lax. The quadriceps femoris tensor vaginae and gluteus medius are firmer. The gluteus maximus midway between the other two groups in firmness. The leg muscles especially those on the outer and outer and posterior surfaces are held firmly by the deep fascia.

a3 When adduction is added to inward rotation of the thigh in the plane of the original flexion there is tension on the fascia lata especially in a grooved band which is formed in front of the great trochanter and behind the tensor vaginae running thence upward and backward while a second is formed running downward to the external condyle of the femur if not to the external tuberosity of the tibia (Fig. 14 a).

a4 Extension of the lower extremities now causes diminished forward rotation of the pelvis apparently from diminished size of the fulcrum of the thighs and buttocks due to the removal of the mass of fat over the latter when this deficiency is supplied mechanically as by interposing a binder the rotation appears to be the same as at first.

a5 When the knee is extended in the plane of the spontaneous position of the thigh there is resulting tension on the adductors and on both hamstrings when the thighs are first adducted there is tension only in the outer hamstrings.

a6 When the lower extremities are adducted and rotated inward extension at the knee is favored by outward rotation of the pelvis at the knee then forward rotation of the pelvis is marked.

a7 In the thigh flexed adducted and rotated inward and laterally tension of the leg at the knee (compare with Fig. 15 d) the line of tension disappears (compare with a1) except that it remains much diminished in front of the upper part of the trochanter and extending upward and backward from there. Tension is now visible

o th tbe lc dyl fth f m rande t nalt be os ty  
f the tb and lightly n th h mstrng t d es  
p ally th mt d —but t ry maked

8 Ret rn gth thgh to so i lp t ffl  
bd t d twa d t t dadd get f  
th l g at th k th t hgt ng of ll th h m  
t g m l tt th sat b t o p  
t s y h pt al g th wh l le gth f the  
g l th e p d d poe os fth h mstrng  
m scl l d g th t n gth lo p t fth  
t nd q te m k d th text d go th p t o  
f of th lg pe lly th po ten rpl f th  
l ham t g  
ao Wh th thgh g n th g al p t f  
fl bd to nd t d t t add t t  
f the tl gh t vth gul d mpl f the  
f n th ghbo hood fth t p fo t d t  
f fth to ch t with to g l g f t b  
h d th t ch t d d p s m fth l k st k  
p th gl t m m s d th po t p t fth  
gl t m d

O th d t d l w t m tv th l f  
t e f c th j t d f th h doe t d pp  
h the k te d d (C mp th 7)  
I g th f l t t l y m d v l  
tw th t h t r d th kn m m d t  
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with fl fth k d pp l p t n l b  
d g t d f th t xt  
I g th f l t th to ch t th t  
p sly p t l b d t d sapp t m  
t l p p t d l th pt f l gl t m m  
g g a d fl l l h t fl t th th f m  
b d

3 In i th g l d ffl t  
t the kn th r f th l ft th  
m m mb s em t l dl p l t t  
m th pt l t th t h m t g p  
t s n lso m b t tl f d th k  
d that h h t l t th lg l ft  
th t m l pt m t d r y m k d  
t d by th g t t v t g  
th h m t m l th l g t d m t t t t  
d t th k e  
a 4 I t d g th thgh th t k d th l g  
t p po t l p d d t d t t g  
f m t t t d I g th m l po th p t  
f d l th g t t th t th  
g t t t ( l th r y c d l)  
by th n l the t m l ept th  
lt l g f th te pw d f t l y b t  
th m t d y t w d bd t m  
5 I g ll th m g m l bo th j  
t f th m d d l a d l th r d f th thgh so t  
l the k j t t t t y m t l h g  
W th th f th t f th thgh t t dy  
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th l mb p d th p l l m t (ps  
t t)

6 I po i th post g fth l p j t d  
tat g th thgh th p l l d t d f w d t  
spe lly tro g th bt at t d h m ll  
l th py f r m d t l l th i d t f  
C t th tl h th bt t  
t l g m ll t l l t t b t ft  
th g m l d t t g th p l l d tly  
fo w d t m th p t eo ly th gh t q t  
mpl t ly—th post p t fth p l i ry t  
p l bly th t d w th thgh f t g t w d  
t d t t

7 Add ct on n w m nearly compl t spo t ne  
o sly I i g the te don f th p lt adduct  
n d t t em g spont ly stll m

mpl te  
8 I when e yth g mov d fr m ou d th  
h p j t th me f w d ot t n f the p l s a d the  
oc t d f d p s n of th l l mb sp e  
t e

9 W n th thgh bd ted d t ted t rd  
th p t po t eo ly med t t m the c p l  
f th h p j t s t ght bl q ely dow w d a d  
tw d to th k f the f m th h ad fth f m  
l k f w d d lttl wa d th t ch t look  
b k f d d lttl t d the l s to ch t  
d t d d w d w d d f d The t n l  
f fth f m th b l th po t  
lightly n

Aft th vp f the n p d pul fth  
h p j t d th t t fth thgh w d th t th  
p l l d t d f r w d th p l eent b tw t d  
t l f m k g t g b po wh h the h d fth  
f m p f m b r d Th t g f the c p l  
l t d th k it d ho t th o ecto  
b t th p l d th f m that th y m d p a  
t lly bo be t at th l f po t eo f o  
d wh e th l d f th p l th h bo  
m d k d t d g th l t m t  
th tru k th pp d f th f mu d th p l m  
f d t g th

l t f th th h p lly h add ct d  
d t t d d lt f d t t f the p l  
d t h g f th l mb p o e  
f th l mb th p Wh n th l t t g  
ff t d r n l p d d f d t t fth  
th

At th m t m th t th l d m t ed  
l g th t t p t f th r s l t  
p t p t fth p l t t d f m l w ep d  
m k th p t ll f th j t th k nd firm  
l m k tl f a l p l p ct lly lso fom  
b h l I th p t t th ly m ts p bl  
th th j t t m t f l d t  
y lght dd t l wh th p l l  
d t d fo d th t h t tll look m h t  
b k d d th l s t h t t tly l k a d  
3 lh c pl h p nt tnd y t  
tw t a d th ll th f m t y ld to the d pfb  
t wh b bdu t t d t t t d

4 D t ll f d te d y f m the  
p l of th k p t ly ll f l t f  
th l go th thgh b t th p t fl d p to  
f th k m b t th m t fth  
p p g ng fth l we d fth f m ry g w th t  
th pp d fth l h Th d c t fth nd fth  
f m m to b p t d by th t d l m t u  
g f m j t b l wa d t l t th t f  
p f t l m t th f m f m th b fth l  
t h t l b l y f a d i up d C t t g th t  
t d th t b d g g t th l t t l l

f t f lly p g th p l l th l  
d f th f m t f l l th gl t mpl tly l g  
th p l b h d b l w d t m k m l h g  
l t ng t b h l dab llo th h d to p j ct  
f t l y d th j l l th p m t th l l  
l lly t f l l i th k t m p t ly

t n  
D t G p b K e d f ot  
b L t d g th l go th thgh t the kn  
m k d tr t th m l m th s d f  
th t b a pp tly m t p no n d on th d

and producing a groove below and in front of the internal malleolus and still more marked behind the malleolus it also produces tension on the scaphoid and on the sole of the foot below the bone also along the metatarsal bone.

b<sub>2</sub> The foot continues the line of the leg which describes a slight curve the concavity being directed medially. The inner edge of the foot forms an angle opening inward about the level of the scaphoid or a little anterior to this bone. The first metatarsal bone and the great toe form the anterior limb of this angle, this anterior limb extends forward and still farther medially. When the knee is extended and the fascia of the leg made tense this position of the foot is more firmly maintained.

b<sub>3</sub> When the knee is relaxed and flexed and the forward part of the foot is taken hold of this latter can be moved laterally toward the ankle both directly and with some rotation a similar rotation can also be developed in this region by grasping the heel from the sole. When the knee is extended these motions are much restricted.

b<sub>4</sub> The tension which extends down along the outer side of the leg when the knee is extended passes to the external malleolus thence to the sole and also to the dorsum of the foot especially opposite the last four toes this last tension is best felt when making slight counter pressure against the dorsum of these toes. The tension is also conveyed behind the external malleolus which is drawn slightly upward and forward the whole leg seeming to rotate inward. The same tension appears to exist on the posterior surface of the leg.

b<sub>5</sub> The heel was originally on a higher plane than the front of the foot. Bring the forefoot up into the same plane as the heel makes the tendo achillis tense especially towards the inner head of the gastrocnemius which latter appears to become displaced toward the antero internal side (tension in fascia). It is easier to evert the foot after cutting the tendo achillis not direct eversion but the heel rotates forward and inward.

b<sub>6</sub> When in the original position of flexion the thighs are adducted and rotated inward both the legs and feet are held in the same relative position. The crest of the tibia looks inward and a little forward. Without changing the position of the thighs the crest of the tibia can be brought directly forward only by outward rotation of the leg at the knee. Eversion of the leg at the knee is favored by outward rotation of the leg at the knee then forward rotation of the pelvis is less maintained.

b<sub>7</sub> When the thighs are adducted and rotated inward the foot looks inward and a little forward if held so the foot can be brought directly forward by slight rotation but it can not be abducted so that the toes are directed forward and outward without being also everted.

b<sub>8</sub> If the leg is rotated at the knee so that the crest of the tibia looks forward the foot can be abducted slightly (10 degrees or less) without eversion. This is about the usual relation between the axes with reference to the axis of the crest of the tibia which is directed inward to the axis of the foot and if prolonged would terminate about the tarsometatarsal joint. To bring the foot into the axis of the tibia the toes must be turned in.

b<sub>9</sub> When the lower extremity is extended adducted and rotated inward so that the patella looks forward the foot can be so as to continue the internal concavity of the leg the ends of the toes lying in an oblique line the end of the great toe being the most distal.

b<sub>10</sub> After the hamstring muscles are incised the leg tends more to rotate outward at the knee. After all the muscles below the knee are incised also the vessels and nerves including also all the deep and superficial fascia except such as keep the knee joint intact the knee still returns spontaneously to flexion (a24).

From the dissections noted it might appear that the close union of the pelvis and the femur at term is due to limitations present in the capsule of the hip joint. But it will be noted that these dissections were made by examining the hip joint with the fibrous tissues of the pelvis and of the thigh more or less intact. It will also be noted that as the fibrous tissues of the thigh are incised the action of this region upon the pelvis becomes progressively lessened (a15).

In another series of dissections by means of fractional circular incisions of the thigh from the knee upward extending inward to the femur the pelvis and the capsule of the hip joint were freed from the action of all connections with the firm fibrous tissues of the thigh and it was then found that the head of the femur moved freely within the capsule without affecting the pelvis. Hence the inference appears justified that the pelvis is acted upon as above by the femur because of firm fibrous tissue connections between the pelvis and the femur and between both of these and the capsule of the hip joint.

Thus this study shows that through its firm fibrous tissue connections the thigh exerts a powerful influence upon the body form—as far caudad as the feet and toes and as far cephalad as the abdomen and thorax. Its influence caudad is seen to be exerted through the direct continuity of its fibrous tissues—not only those related to the deep fasciæ and the muscles but also those of the great nerve trunks and affecting markedly the bones and the articulations.

Its influence cephalad is more complex. The continuity of its firm fibrous tissues is less simple and its influence is exerted more directly upon and through two other complex structures—the pelvis and the lumbar spine (both singly and in combination) and thence to the lower thoracic vertebræ and the thoracic cage and through this latter to the cervicothoracic vertebræ and the head. We are thus led to the study of these more cephalad structures.

#### THE ANTEROPOSTERIOR SPINAL CURVES

Four anteroposterior spinal curves are developed in the supine position at birth—

cervical and lumbosacral anterior convexities and thoracic and sacrococcygeal anterior concavities. Of the four curves two are organic (the lumbo sacral and the sacrococcygeal) and two are functional (the cervical and the thoracic) (Fig 8 d i e j 8 Fig 11 c f).

Th p t l f th p l k t h hld  
ly th p p t th ts l t m t  
th p t p t ffl th ts l on d tw d  
t t d th t h d th po t of the fl  
wh h t t d p t ly t m th p te  
h t l pl f th h d tru k pp t fo m  
b k e l f m th l b h od f th p t l  
p t b t the b t k (Fig 8) B t th pp t  
f th p m l d g d d t th b g f th l  
p by th ft t  
L v k th hld (w th th l w e t e t p th  
th h d t d d th t th f l th f t l pl th  
p l l w th th t p w l h th t k t (Fig 8 l)  
p t d f s ft pl t f p t t th t th m  
p t f th p l th l ck b g d l l  
lght fl t d p t o y l ty m g  
g bly t lght y d l mb ty m g  
p t ty h h nt m h lmo t s  
fly t v lghtly m k d l g d d p t  
tl ty Th t t d th l  
b p ty b p tly t ll m k l bt l  
d ed l p d d t l pp m fl t l t  
d h b l t l l y t th h t l pl p  
h h th p t t (l 8 d mp th F 8  
l g d)  
I y k th hld p d b l f ft pl t f  
I d m k h h pt b f l y g th m  
d t b h th l t m t t l p t t l  
p t f t l l u t d f d t t  
(l 8 c) t m k d fl t d y g l  
p t ty m b g l l d t w l l m k d  
l mb c l p t a t wh l m g d t l y  
ph l d t ll m k d th l l g p  
t ty Th l t t m t d d h l  
p m d th p d b t B t th l  
h rp d h t p t l m h m d f t  
m knk f m d t d p (l 8  
d mp th l f)

*The cervical spine—curved and straight*  
*spontaneous tendency toward flexion of the*  
*head and neck* When the head of the child is  
unsupported it yield to gravity and falls  
freely either forward or backward and less  
freely to one or the other side. These bend-  
ing movements take place not between the  
head and the spine but in the cervical verte-  
bræ the only direct movements of the head  
on the latter being the slight nodding move-  
ment of the occipital condyles on the articular  
masses of the atlas. In all other movements  
one or more of the cervical vertebræ move  
with the head. The forward and backward  
bending movements may be direct but they  
tend to be accompanied by a lateral move-

ment which adds more or less lateral rotation  
of the cervical vertebra.

In the supine position with the occiput  
resting on the same horizontal plane as the  
trunk the head spontaneously assumes a  
position of more or less flexion the chin tend-  
ing to come to rest more or less above the  
level of the sternal notch. When the face is  
held anterior the head in this position rests  
upon the lower part of the occipital protu-  
berance. But it can not balance spontane-  
ously upon this small point so when support is  
removed it tends to rotate laterally (the face  
looking more and more outward as well as  
forward and a little downward) to one or the  
other side tending to come to rest on the  
occipitoparietal lateral junction on the occipi-  
toparietotemporal junction or even on the  
lateral surface of the parietal bone above the  
temporoparietal junction (Fig 1 b h  
Fig 3 b c i j).

Th d f t l l th t d cy t  
po t fl f th h d th p t W th th  
th c p fl h l t th t bl a d th  
pp ple f th c l p d b the tabl t  
a t e c po d g w th d t c t whch th  
a t l b s f th o c p t pl d t o to th  
pl f th s ppo t p t f th h d t r c l sp  
b m th t f t g l l tw tw ppos g f c  
—th h d (d t s t t h m t) h h t d to bri g t  
t the l f th t l b f th p t d g t  
th c p (l t t h m t s) h h t d t b  
t t l th t e l f (l 8 o b d) ( t y d th l t t  
d by f l t th fl f th l t bræ t wa d  
the tabl d m b g th t l b f the p t  
th t bl d m t d fl ing th h d  
Th t t m m t g ty t l o m o th  
t p t f th h d d d d a m d r e t  
l m t d fl (Fig b) Acc so y f c t  
h t m k t d k p g th l  
t b æ t d y f m th pl s f th a t c l  
b f th p t d of th th c c t b æ r sp c  
t ly (Fig 8 f)

*Development of cervical anterior convex*  
*curves with or without lateral deviation and*  
*with or without lateral curvature* As soon as  
the child is born and falls supine upon a  
resisting surface whether the head falls into  
spontaneous flexion or is more or less extend-  
ed it tends to develop a cervical curve the  
convexity of which is anterior and also a  
little toward one or the other side with some  
rotation of the vertebral bodies toward the  
line of the face.

When the head falls in spontaneous flexion  
with the occiput resting upon the same

supporting plane as the trunk palpation reveals a slight high anterior cervical convexity (similar to Fig 8 f) with convexity perhaps increasing somewhat and adding a lateral deviation as the flexed head falls sideways (Compare with Fig 9 a b c d)

If now the head is extended so that the face moves into a plane parallel with the horizontal plane upon which the trunk rests one notes a developing tension of the soft tissues on all sides of the neck which latter narrows and elongates this tension leading towards upward and forward traction upon the front of the thorax. The tension and traction are exerted upon the thorax both directly and indirectly the latter through the medium of the anterior portion of the shoulder girdle the clavicle (Fig 3 f g Fig 8 compare a and b). Palpation now reveals a more marked anterior cervical convexity which extends lower down towards the thoracic region.

A lateral deviation is added if the head is rotated to one or the other side. This lateral deviation may extend downward through the cervical region and involve the cervicothoracic junction or even the upper thoracic vertebrae. The spines follow the occiput so the convexity of the lateral deviation (spinous processes) is to the side opposite that upon which the head rests. The lateral deviation is accompanied by some rotation of the bodies of the vertebrae these bodies moving in the direction of the face (compare with Fig 9 a to h).

In connection with the lateral rotation of the head there may be developed also a tendency toward lateral curvature of the cervical column. This is because of the fact that the final support of the head may pass to a higher or a lower level than its junction with the upper cervical pole which is thus called upon to ascend or descend while the lower cervical pole tends to be kept near its former level by its attachments to the shoulder girdle and the thorax (Fig 9 compare a to d with e to h). The transmitted stress increases with the extent of the rotation and as it is difficult for the cervical vertebrae to curve laterally the stress extends directly to all the tissues of the column of the neck. Attempts to relieve this stress by turning the rest of the body to follow the

head may increase the stress on the cervical column if the lower pole of this column is thus raised still higher above the supporting plane by the greater lateral extension of the shoulder to the outer side of the spine. This calls for a relatively greater descent of its upper pole to permit the side of the head to rest upon the same supporting plane. (It is important to note that the lateral position leads to a forward sliding of the whole shoulder girdle.)

A cephalocervical posterior concavity extending upward beyond the cervical region to the occipital protuberance is more or less evident (Fig 8 g Fig 9 a to h) according to the degree of backward extension of the occiput beyond the upper cervical pole and according to the amount of soft tissues present.

When the mandible the attached tissues in front of and to the side of the cervical spine and also the clavicle are removed and the head is then allowed to fall forward in spontaneous flexion the front of the cervical spine is seen lying in an anterior convex curve which is less marked than before dissection while the back of the cervical spine and the cephalocervical posterior concavity are both obscured by the soft tissues (similar to Fig 8 f compare with Fig 3 h). Then if the head is placed in midextension so that the face is in a plane parallel with the plane upon which the trunk rests the anterior convexity of the front of the cervical spine increases the back of the neck is raised from the table in a poster or concave curve which merges with the now visible cephalocervical posterior concavity both somewhat broken by the sagging of the soft tissues (Fig 8 g). As the soft tissues are gradually removed from the mandible and from the front and sides of the cervical vertebrae the tension and traction upon the clavicle and thorax progressively diminish these latter fall a little downward and backward (compare Fig 3 h with Fig 8 g).

Removing the soft tissues from also the back of the cervical spine and from the occiput below the protuberance but leaving the nuchal and other ligaments sufficiently intact to preserve the relations between the occiput and the cervical spine as well as between the individual cervical vertebrae and placing the head in forward flexion one notes the disappearance of all the cervical curves described. The cervical vertebrae with the exception of the atlas and perhaps a little of the axis lie in a straight line horizontally on the table the ring of the foramen magnum is carried forward and looks a little backward and downward and the atlas owing to its close connections follows the articular base of the occiput and with perhaps the aid of the axis forms the cephalic arm of a slight anterior cervical concavity. The cephalocervical posterior concavity almost disappears the head and neck lying on the table in almost a straight line from the lower part of the occipital protuberance downward (Fig 9 a b compare with Fig 8 e f g). In these illustrations the cervical anterior concave curve does not appear because in the dissected subject the apposition of the occiput and the atlas with the immediately succeeding cervical vertebrae is so close that the line of their separation is not shown. But as soon as the acuteness



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*Development of the straight cervical spine with or without lateral deviation and with or without lateral curvature* The foregoing experiments seem to demonstrate that extension of the head develops the cervical anterior convex curve while flexion of the head causes this curve to decrease or disappear and especially in the dissected specimen made by removal of all the soft tissues to be replaced by a more limited anterior convexity or even by a short high anterior cervical concavity the rest of the cervical vertebrae lying straight.

But further study of these experiments shows that the real factor in producing the above anterior cervical convexities is the anterior inclination of the cervical spine which is developed even when the head is in spontaneous flexion by arbitrarily displacing forward the articular base of the occiput and the closely connected more mobile upper cervical pole into a plane which is anterior to the plane in which the less mobile lower cervical pole is held by its continuation with the more stable thoracic vertebrae. And this forward displacement of the articular base of the skull which occurs in the supine position even when the head is in spontaneous flexion is increased with extension of the head because in the upward and backward rotation of the head upon a transverse axis which occurs when the head is extended the area of excursion of the back of the head is in this position limited by the resisting surface of the table upon which the head rests.

When this resisting surface is removed and the head left free to rotate the occiput takes its normal position posterior to the cervical vertebrae the articular base of the occiput is not displaced forward anterior inclination of the cervical spine does not occur and extension of the head to bring the face into the frontal plane does not produce a cervical anterior convex curve. The upper cervical pole (and its union with the articular base of the occiput) and the lower cervical pole then lie in the same plane and the cervical spine remains straight. Secondary modifying factors are the attachments of the segments of the cervical spine anteriorly to the cranium and to the front of the thorax including the thoracic portion of the shoulder girdle and posteriorly to the cranium and the back of the thorax including the back portion of the shoulder girdle (Compare Fig 9 a to h with Fig 10 a to h). A lateral deviation occurs also in the straight spine if the head is rotated to one or the other side. But the tendency toward the development of a lateral curvature as the result of the lateral stresses noted under the development of the cervical anterior convex curve does not exist in the same degree because in this position the straight cervical spine is supported by the horizontal plane upon which the trunk rests (Fig 10 c d g h).

I Fig 8 f a d g i t o t e d th t t h occiput t  
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 Fig 8 4 5)  
 I Fig a th p t s t up th same h iz t l  
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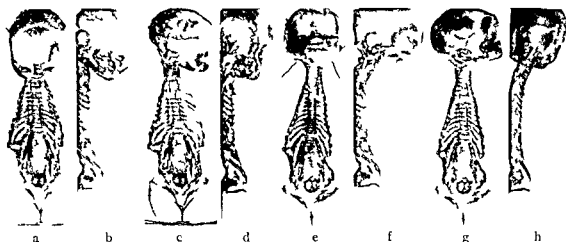


FIG. 1. Showing the cervical curve with the additional demonstration of the lumbosacral anterior or convex curve a to h. The same subject and the same positions as those shown in Figure 9 except that the lower extremities have

been extended adducted and rotated inwards thus adding a forward and downward rotation of the pelvis and resulting in an extension of the lumbosacral anterior convex curve.

the rest of the cervical spine lying straight (compare with Fig. 8 e 6).

If no change is made but to rotate the head so as to bring the face into the frontal plane (Fig. 11 d) a cervical or cervicothoracic anterior inclination or flexion and a cervical or cervicothoracic anterior convex curve are developed as in the preceding cases (compare with Fig. 8 e 3 8).

But if the cervical spine is straightened and the head allowed to rotate in the same way after all obstacles have been removed from the path of the occiput (Fig. 11 g) the cervical spine lies upon the horizontal plane while the occiput comes to rest dorsal to the line of the spine. And again there develops no anterior inclination or flexion nor curvature of the cervical or cervicothoracic spine; this remains straight (compare with Fig. 8 e 4 5).

In the casts in Figure 8 e 4 5 there is shown a slight anterior concavity which may be due to the fact that the occiput was brought to rest at a slightly higher level than that which would bring its articular base into exact line with the cervical spine. If the support for the occiput be not adjusted exactly the atlas may rest on the edge of the horizontal plane supporting the cervical spine and the trunk. As a result the articular base of the occiput may sag and the sag transmitted to the anterior articular element may raise the cervical vertebrae in a slight anterior or convex curve from the second to the seventh with its maximum about the fourth. If on the other hand the articular base of the occiput rests on the edge of the horizontal support plane this causes it to move a trifle forward of the line of the cervical column perhaps carrying more or less with it the atlas and producing a slight anterior or concavity similar to that seen in acute flexion of the head in Figure 8 e 6. When the occipital support is correctly adjusted the stress is divided equally between the anterior and posterior vertebral ligaments and no abnormality in the straight cervical column is observed.

In the supine position when the cervical spine is straight a slight anterior convexity is seen along the ventral surface of the lower cervical and upper thoracic vertebrae (Fig. 8 e 1 2 4 5 7 Fig. 11 d g). This appears to be due to two causes: (1) the forward projection of the vertebral bodies due to the pres-

sure forward upon the spinous processes by the resistant supporting surface and (2) the increasing depth of the vertebral bodies and the increasing length of the spinous processes in this region. The spinous processes of the thoracic vertebrae continue to increase in length but they also become bent forward at an angle and become imbricated. As this change occurs the anterior convexity of the ventral surface decreases and the thoracic spine appears straight or by contrast with this temporary cervicothoracic anterior convexity and the definite lumbosacral anterior convexity the thoracic spine may appear to show a slight anterior concavity. As the cervical vertebrae are raised the pressure from beneath is lessened or removed the anterior convexity of the ventral surface disappears (Fig. 11 d Fig. 8 e 3 8) and the increasing depth of the bodies and backward projection of the spinous processes are clearly seen (Fig. 11 d).

Although the straight cervical spine is consistent with full extension of the head a cervical anterior convexity may be developed by continuing the rotation of the head into hyperextension this movement without forward inclination or flexion of the cervical column displacing backward the articular base of the occiput and the attached upper cervical pole (Fig. 7 compare e with d). Again with the head extended to practically a right angle with the uppermost cervical vertebra (the relation existing in the straight

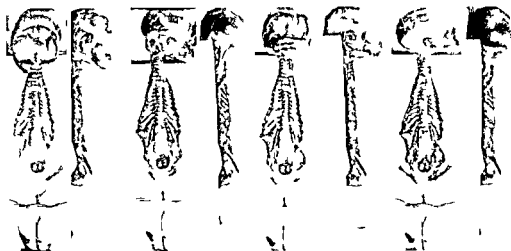


Fig. 3. Th. t. ht. l. p. th. dd. dd. m. h. t. t. f. th. l. ml. l. t. t. S. m. b. j. t. d. m. p. t. t. F. d. pt. th. t. th. p. t. t. d. l. th. fl. d. t. f. th. h. l. i. t. ll. d. t. k. t. m. l. p. t. d. f. t. th. t. ht. l. p. f. lly. m. a.

t. t. l. t. l. pl. h. l. l. (d. s. d. th. th. t. p. h. h. th. t. k. t. b. t. p. ll. l. t. t. N. t. th. f. f. th. l. l. t. l. tu. wh. th. h. d. l. b. t. t. d. t. th. th. s. d. e. l. th. h. th. l. t. l. l. t. d. s. p. p. e. b. t. t. o. m. h. t. l. d. t. t.

cervical spine) the cervicothoracic spine may be inclined forward in a long anteriorly concave curve. Without altering this long curve further extension of the head (hyperextension) would lead to the development of a cervical convex curve as just noted in the straight cervical spine (Fig. 11c).

*The cervical anterior convexity is not an organic curve at birth but is the result of postnatal factors.* The final conclusion from this study is that no cervical curve are organic at birth; all are postnatal and are developed as a result of the struggle between (1) the instinct to bring the face into the frontal plane and (2) an acquired forward inclination or flexion of the cervical or cervicothoracic spine. The former is antagonized and the latter is favored by the anterior connections of the head and of the neck and its viscera with the shoulder girdle and with the trunk and its viscera.

Th. ty. f. both. f. th. f. t. ll. t. t. d. f. ou. H. th. h. b. p. m. t. lly. d. l. p. d. ( ) f. d. l. t. fl. f. th. thora. c. p. d. ( ) t. th. s. h. b. dd. d. t. d. t. f. th. h. d. Th. s. lt. a. t. t. f. th. c. th. p. d. th. f. l. t. p. al. f. b. t. 6. dg. w. th. h. t. l. pl. h. h. th. t. k. t. If. w. th. f. b. b. ht. t. th. f. t. l. p. e. l. a. t. e. s. t. d. l. p. d. b. t. th. q. th. t. th. head.

b. hype. t. dd. d. h. f. th. c. c. tho. c. p. e. b. m. ply. t. a. s. ht. d. th. f. ll. b. fo. d. t. be. th. f. t. l. pl. th. lt. f. th. n. ta. d. e. c. o. f. th. c. p. t. h. th. h. d. w. a. s. e. t. d. d.

The earliest postnatal factor moving toward the development of a cervical anterior convexity is interference with the backward projection of the occiput dorsad to the spine by the bringing of the occiput to rest upon the same plane as the more anteriorly attached spine as in the ordinary assumption of the supine position. This factor is present even when the head is flexed but its action increases as the head is extended. When the occiput is given free play to find its normal position dorsad to the cervical spine the cervical spine remains straight whether in flexion or extension.

The free movement of the cervical spine at term when the excursion of the head is not restrained shows that the firmer fibrous tissues connected with the bones exercise a less marked influence on variation in the relative position of the individual vertebrae than do the softer tissues (muscles and viscera) and their related fibrous tissues. The curves being more and more modified as these softer tissues are removed. Hence it seems apparent that while the anterior inclination or flexion

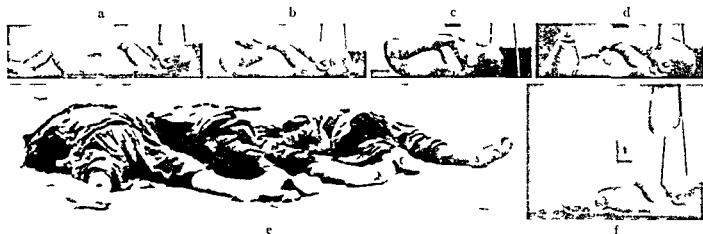


FIG. 14 Some intermediate stages occurring in the lower extremities as they pass from the prenatal position of flexion abduction and outward rotation toward the advanced postnatal position of extension adduction and inward rotation so that the patellae look forward. a Same subject as in Figure 1 but the head has been allowed to fall in spontaneous flexion with slight rotation to the right and with the lower extremities adducted and rotated forward in the plane of the spontaneous flexion of the thighs. Because of the firmness of the deep fibrous tissue contractions there is a slight return toward abduction and outward rotation of the legs and feet. b Same subject as in 14 a but approximate return to the intra uterine position of flexion of the lower extremities on the pelvis and of the pelvis on the spine. c Same subject and same position as

in b but with increased flexion of the pelvis and lumbar spine the knee is also extended and the thighs come what adducted to allow for the increased pressure of the abdominal contents from the increased flexion of the spine. d Same subject and same position as in 14 a but with the thighs adducted rotated inward and flexed at an angle of 90 degrees with the plane upon which the trunk rests and held in this position by being tied just above the knees to a vertical plant. On account of the firmness of the deep fibrous tissue contractions the slight return toward abduction and outward rotation of the legs and feet. e Newly dead adult men (T. S. H. Id. II. Id. P. I. O. S.) shown in spontaneous assumption of the at term position of abduction and outward rotation of the thighs but with the lower extremities extended at the hip and knee joints.

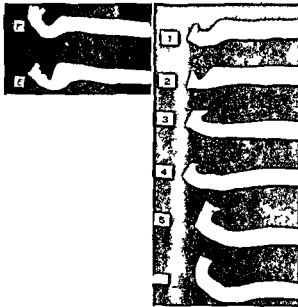
of the cervical or cervicothoracic spine is determined by the relative positions of the articular base of the occiput and the lower pole of this portion of the spine curved variations of the line of this anteriorly inclined spine depend upon variation in the balance of the muscles and viscera thereto attached the location of the angle of flexion depending on the location of the point or points upon which the force of the flexing factors converge. Hence the curve may develop more markedly from the upper pole or from the lower pole.

The ease with which at term the cervical spine can be straightened or overflexed or overextended suggests that an equilibrium has been evolved in the deep fibrous tissues as well as between the muscle flexors and extensors. But the cervical viscera remain to be considered and two facts regarding the cervical viscera attract attention in this direction. (1) these viscera are all located on the anterior or anterolateral portions of the cervical spine and (2) nearly all of these viscera have continuous relations with the flexor surface of the trunk spine and the trunk cavities and their contents.

#### THE LUMBOSACRAL ANTERIOR CONVEX ANGLE OR CURVE

It has already been shown that a lumbosacral anterior convexity (angle or curve) develops in prenatal life and is present at term even when the lower extremities fall into their spontaneous attitude of flexion abduction and outward rotation (Fig. 8 d 1). The lumbosacral anterior convexity differs from the cervical curves in that it is an organic curve being fixed in prenatal life by the connections of the involved bones although it is capable of functional modification. Its basis is a more or less pronounced hyperextension of the sacrum. But the study made in Figure 17 j k shows that antecedent to the hyperextension of the sacrum a lumbosacral rounded angle or an anterior convex lumbosacral curve is present in the straight spine this angle or curve being formed by the continuation of the lumbar vertebrae with the rapidly decreasing anteroposterior diameters of the sacral and coccygeal vertebrae.

This study has also shown how the lumbosacral curve is related to and modified by the position of the lower extremities (thighs)



curve apparently develops as the anterior body concavity of the embryo straighten with extension of the spine and that it apparently becomes fixed as the pelvic bone become attached to the spine and to each other. Thus at term in attempting to restore the earlier anterior concave curve of the spine by flexing the pelvis upon the spine through the medium of the lower extremities and carrying the flexion progressively upward we can practically completely change the lumbosacral anterior convexity to an anterior concave curve only a slightly projecting ridge marking the location of the former lumbosacral angle. The organic nature of the curve is shown by the persistence of this ridge in spite of the flexion is a whole and by the compression which the act of flexion is seen to exert upon the intervertebral discs as high up as the eleventh or twelfth thoracic vertebra. By successive separations of the pelvic bone from each other and from the spine without other change of position the lumbosacral anterior convexity can be gradually but entirely removed except for the line of demarcation at the upper end of the sacrococcygeal inclined plane (the lumbosacral angle) the inclination of this plane now appearing to be due to the decreasing anteroposterior diameters of these terminal vertebra.

Now h t l i t m t p l d t h l  
w d t t t l t h p t l l k f d t h p l  
t t f l d n d p t m r s  
d t p t l p t f t h m a d p p  
p t f t h c y l t h s m ( p d t s p l )  
t t f d t t g l a t h t h t h m f b  
t t l m t s t h f t h l u m b t l a t t l t  
f l l f t h f i t h m m t d c g f m b  
l u p d t h m m t t h t d  
H t h p p l m b r t l a e l i  
f r a d y t h t p l l f t h f m t g t h g h  
t h p o l a c T l u l t t h c s f t h l m

I t h p p t t h t l r t m t t h  
p t t f l o b f t d t d t t o  
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Now h t l i t m t p l d t h l  
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p t f t h c y l t h s m ( p d t s p l )  
t t f d t t g l a t h t h t h m f b  
t t l m t s t h f t h l u m b t l a t t l t  
f l l f t h f i t h m m t d c g f m b  
l u p d t h m m t t h t d  
H t h p p l m b r t l a e l i  
f r a d y t h t p l l f t h f m t g t h g h  
t h p o l a c T l u l t t h c s f t h l m

acting through the intermediation of the pelvis. Further study seems to show that this

bosacral angle into an extended anteriorly convex lumbo sacral curve which may even extend upward so as to form a lumbosacrothoracic anteriorly convex curve (Fig 8 c d 2 1 1 2 a to h 1 1 3 a to h)

Beginning with flexion of the lower extremities on the pelvis and of the pelvis on the spine as in the intra uterine position (Fig 14 b compare with Fig 1) and in creasing the flexion as in Figure 14 c but to a still greater degree the lower extremities being more and more abducted we find that the lumbosacral curve and angle disappear except for a slight remnant ridge at the site of the former angle. The lumbar spine and the sacrum now form a continuing line very slightly curved with the concavity anterior. This curved line caudad to the line of the thoracic spine begins in slight hyperextension. Several slight subsidiary ridges above and below the lumbosacral ridge show the amount of pressure and tension undergone by the intervertebral discs. The tip of the sacrum and the coccyx continue the floor of the pelvis in a curve the concavity of which looks cephalad. Hyperextension of the spine which formerly lay in line with the sacrum is now seen beginning faintly in the upper lumbar vertebrae (Fig 15 3 4 In 3 the ribs are more abducted so that the knees rest on the box just outside of the ribs)

If the flexion is still more increased the lumbosacral concave curve deepens yielding being least in the lower lumbar and upper sacral regions more of the sacrum enters into the pelvic floor which deepens and grows broader from behind for a distance. Hyperextension of the lumbar spine is now definitely indicated being more marked above less marked below as it curve forward to join the sacrum (Fig 15 5)

Finally increasing the flexion to about the lumbosacral junction we find that the crests of the ilia point practically do inward and the anus points upward and a little backward. The lumbosacral concavity deepens the lumbar and the lower sacral vertebrae entering into it more definitely the lower lumbar and the upper sacral regions still yield no least. The floor of the pelvis broadens still more from behind forward as more of the lower sacrum tends to enter into it. Hyperextension of lumbar spine is more pronounced above and less marked below (Fig 15 6)

When the lumbosacral anterior or convex curve is deepened to a maximum by extending adducting and rotating inward the lower extremities so that the patella look forward and then an incision made through the symphysis pubis the lumbosacral anterior concavity shows a definite relaxation and flattening of the curve (Fig 17 a 1). If additional incisions are made through both sacroiliac articulations the lumbosacral anterior concavity shows a much more marked relaxation and flattening of the curve (Fig 17 c d). The tension of the sacroiliac joints on the right side upward through all the soft tissues to the fifth rib causes further marked relaxation and almost complete disappearance of the curve with aging in the left pelvis is less and rotation of the pelvis and lumbar vertebrae to the left and development of a slight lumbosacral concave curve which can be traced right has the second thoracic vertebra. On the left side the ten psoas muscles seen holding up the left pelvis (Fig 17 e f)

Connecting the right lateral incision with that through the symphysis and continuing it up a distance along the right side of the iliopectineus we note that the lumbosacral posterior concavity has disappeared but the iliopectineus is seen near the iliac crest and tendon of the iliopectineus is still in place. In the lower left concavity can be traced especially in the mid thoracic vertebrae but the lower thoracic and especially the upper lumbar vertebrae are drawn to the left by the psoas iliacus and quadratus

lumborum the sacrum and coccyx swinging to the right, the separation of the sacroiliac articulation (Fig 17 g h)

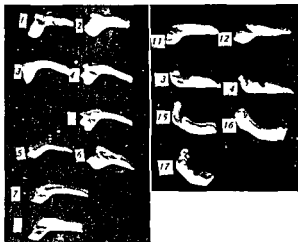
After the removal of all tissues on the left of the spine as previously done on the right the spine lies straight and flat the only trace of curvature being the postural anterior concavity at the cervicothoracic junction already noted (the anteroposterior diameters of all the vertebrae increase with the sum of the diameters of the bodies and the back and projection of the laminae and spinous processes as the spine rests on a non yielding surface) and the anterior convex curve of the anterior surface of the junction of the fifth lumbar vertebra with the sacrococcygeal inclined plane or anterior concave curve no posterior spinal concavity existing when the head is allowed to extend without obstruction to the occiput (Fig 17 i j k)

#### SACROCOCYGEAL ANTERIOR CONCAVE CURVE

The sacrococcygeal anterior concave curve is an organic curve developed in prenatal life and present at term

Beginning with the attempt to restore the embryonic interior concavity of the spine from the lower thoracic region to the coccyx (Fig 15 6 compare with Fig 16 17 15 16 and with Fig 14 c) and reversing the steps of this experiment one sees that progressively as the flexion of the lumbar spine and pelvis decreases and moves into extension the lumbar spine decreases in hyperextension and falls into line with the thoracic spine the latter losing the slight concave convex line developed by the stress from below and becoming straight (or with a very slight anterior concave curve) (Fig 15 3 4 3 F compare with Fig 16 15 16 15 14 11 12 1 - and with Fig 14 c b d Fig 2 a) At the same time the sacrum first follows the lumbar spine in becoming straight (Fig 15 4 3 and then moves into hyperextension (forming the lumbosacral angle whose apex is directed anteriorly) being now directed obliquely downward and backward with a tendency to become slightly concave anteriorly particularly in its lower portion (Fig 15 F compare with Fig 16 1 2 and with Fig 1) The coccyx follows the sacrum but does not so entirely lose its forward direction thus giving with the lower part of the sacrum a definite suggestion of interior concavity to the posterior wall of the pelvis (Fig 15 F Fig 8 e 1 to 8 compare with Fig 16 1 -)

However other processes than extension and hyperextension of the spine are involved in the production of the sacrococcygeal anterior concavity. Figure 17 i j k show the



marked changes which have taken place in these vertebrae as compared with those more cephalad especially in the direction of diminution of their ventrodorsal diameters this factor tending to produce an anterior oblique or concave line when seen in profile even though no posterior convexity appears

#### MODELING OF THE PELVIS

*Modeling of the pelvis (the abdominal floor) by the lower extremities and the lower spine*  
This study has previously shown that flexion and extension of the lower extremities (thighs) produce respectively backward and forward rotation upon a transverse axis of the pelvis as a whole and the preceding study of the lumbosacrococcygeal spine has shown marked changes in the modeling of the posterior wall of the pelvis as this latter structure is more and more flexed upon the spine (Fig 15 3 to 6 compare with Fig 16 11 to 17 and with Fig 14 b c d)

Summing up the intrinsic modeling of the pelvis at term by the lower extremities (thighs) in the supine position one note that flexion of the thigh move toward making the pelvic cavity more rounded less deep broader laterally and broader crudocephalad with relaxation of the floor (Fig 15 F compare with Fig 16 1 and with Fig 14 a) While extension of the thighs moves toward making the pelvic cavity more funnel shaped deeper narrower laterally and narrower caudocephalad with advancement ventrocephalad of the floor (Fig 15 E compare with Fig 16 3 4a 4b and with Fig 14 f) Furthermore the most complete intrinsic modeling of the pelvis is due both to extension and to adduction and inward rotation of the thighs plus extension of the knees this modeling being most complete in the advanced postnatal

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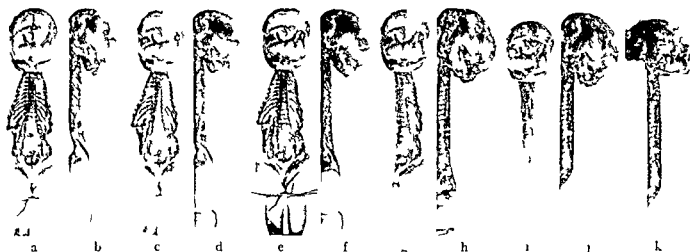


Fig. 17 Experimental study of a second path of evolution of the lumboacral anterior convex curve developed retrogressively by successive sections of the attachments of the pelvic bone to each other to the spine and to the thighs. Consequent reduction of the spine to its earlier condition of absence of all organic curves except the lumboacral angle which latter now appears to be due merely to contrasting anteroposterior deficiency in the sacrococcygeal vertebrae. a b Same subject as in Figure 3 (p. LXXXI). The lumboacral anterior convex curve is developed to its maximum by the tendin adductum and rotation inward the lower extremities. Then section through the symphysis pubis results in a definite relaxation and flattening of the curve. c d Added incisions through both sacroiliac articulations result in a marked increase in the relaxation and flattening of the curve. e f E tendin the right sacroiliac incision upward through all the soft tissues to the twelfth rib causes further marked elevation and almost complete disappearance of the curve with sagging of the left pelvis and loin rotation of the pelvis and lumbar vertebrae to the left and development of a long left lumbothoracic convex curve which can be traced as high as the second thoracic vertebra. The left psoas iliacus is seen holding up the left pelvis. g h Connecting

the right lateral incision with that through the symphysis and continuing it up to the right side of the whole spine the lumboacral posterior concavity disappears from view though it may still be seen through in a small arc and tension on the left psoas iliacus is well shown. k The main of the long left convexity may be traced especially in the midthoracic vertebrae but the lower thoracic and especially the upper lumbar vertebrae are drawn to the left by the psoas iliacus and the quadratus lumborum the sacrum and coccyx swing to the right owing to the separation of the sacroiliac articulation. i j After removing all tissues on left of spine as already done on the right and flexing the head we find that the whole spine lies straight and flat the only trace of curvature being the slight anterior concavity at the upper cervical pole the slight anterior convexity at the cervicothoracic junction (both of these curves having been already noted as being functional and been so demonstrated) and the anterior convex curve or angle formed by the junction of the fifth lumbar vertebra with the sacrococcygeal inclined plane or anterior concave curve no posterior spinal concavity appearing. k When the head is extended and the excursion of the occiput dorsad to the spine is unrestrained the anterior concavity of the upper cervical pole disappears.

position of the lower extremities i e extension adduction and inward rotation

a The spontaneous position of flexion abduction and outward rotation of the lower extremities (thighs) is accompanied by a practically straight lumbothoracic spine and by an obtuse lumboacral angle (apex ventrad) rather than by a very definite lumbar anterior convex curve. From this angle the sacrum is directed obliquely dorso-caudad to the horizontal then slightly curving caudo-ventrad it forms a short curve whose concavity looks ventrad. The pelvic cavity is rounded resembling the end of an elongated melon. The pelvic floor looks rather directly caudad it is almost vertical (dorsoventrad) but forming a slight curve whose concavity looks cephalad (Fig. 15 F compare with Fig. 6 r and with Fig. 2 a).

b Then the adducting and the rotating inward of the thighs so that the knees approach each other (without materially altering the angle of flexion) cause a definite convex curve to appear in the lower lumbar vertebrae: the upper lumbar and lower thoracic vertebrae sagging a little into slight anterior concavity before the former straight line of the thoracic spine is regained. The stress upon the spine is shown by the projection of the intervertebral discs

from the fifth lumbar to the eleventh thoracic. The sacrum passes obliquely dorso-caudad as in 15 F but apparently to a less extent passing into the sacrococcygeal concavity which looks ventrad. This concavity is lengthened and it is more flattened approaching the horizontal. And while the dorso-ventral depth appears shallower it is really the same in its more cephalad portion and increased in its more caudal portion. The pelvic cavity has now become bowl-shaped its cephalocaudal diameter is lengthened it is narrowed laterally and its depth is increased toward the pelvic floor. The pelvic floor is directed a little more obliquely ventro-caudad beginning more abruptly toward the tip of the coccyx (Fig. 15 r compare with Fig. 16 s 6 and with Fig. 14 a).

c Then if the tension of the thighs and knees is added the lumbar anterior convex curve becomes more pronounced and the tendin further cephalad involving more or less of the thoracic spine. The lumboacral angle approaches a well rounded right angle all the lumbar and some of the lower thoracic vertebrae project ventrad in a marked anterior convex curve decreasing cephalad and sagging into a slight anterior concavity just before the straight line of the thoracic spine is regained. The sacrum passes dorsad almost at a right angle and almost in a straight line which includes the upper part of the coccyx. The rest



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#### THE THORACIC SPINE

*The straight thoracic spine the anteriorly concave thoracic spine* In the upine position when the adjacent cervical and lumbar spines are straight the thoracic spine is straight when the adjacent cervical and lumbar spines are curved in anterior concavity this latter curve may extend into the thoracic region (Fig 11 c Fig 13)

When the forward pressure of the resting surface of the table upon the increasingly backward projecting spinous process produces an anterior convexity at the cervicothoracic junction a slight relative concavity of the

adjacent thoracic spine is produced (Fig 11 c 4 5 7 Fig 11 a g compare with c compare with Fig 17 j k)

In proportion as cervical and lumbar anterior convex curve extend into or involve the adjacent thoracic vertebra a more or less marked relative anterior concavity of the adjacent thoracic spine is developed (Fig 11 d 2 c 3 8 Fig 9 compare with Fig 10 Fig 12 compare with Fig 13) Hence anterior concavity of the thoracic spine is a functional and not an organic curve and it is related to both the cervical and the lumbar spine

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#### ROTATION OF THE THORACIC CAGE

The thoracic cage has already been noted as rotating upward and forward upon a transverse axis when the lumbar anterior convex curve developed by extension adduction and inward rotation of the lower extremities extend cephalad so as to involve the lower thoracic vertebra It has also been noted that this action is accompanied by increased stress upon the abdomen and its contents with forward projection of its anterior wall and by downward and forward rotation of the pelvis upon a transverse axis with de cent of the symphysis (compare Fig 14 f with Fig 2 a Fig 8 c with 8 a Fig 6 c f 6 h with Fig 1 f g h)

A similar upward and forward rotation of the thoracic cage occurs when the upper extremities are raised either in front or at the side so that the humerus approaches the side of the head (ear) (Fig 8 h compare with 8 a) the raising of the upper extremity meeting with greater resistance in proportion as the elbow is extended If this resistance be disregarded and the elbow extended the upward and forward rotation of the thoracic cage is increased (Fig 8 i) As the thoracic cage is thus pulled upward and forward it tends to

drag the lower thoracic or thoracolumbar vertebrae forward into anterior convexity and to cause changes in abdominal stress and projection of the anterior walls similar to those just described. This rotation of the thoracic cage with its accompanying abdominal changes tends to be increased when the head is extended (Fig 8 j) and also when the lower extremities (thighs) are extended adducted and rotated inward so that the patellæ look forward (Fig 8 c) the rotation and its connected changes reaching their maximum when all three factors are combined (Fig 8 k).

Rotation of the thoracic cage by the upper extremities is due to contractions (relative shortness) of the deep fibrous tissues connecting these extremities with the trunk and the forearm with the arm. These fibrous tissue contractions have a biological origin similar to those connecting the lower extremities with the trunk and the leg with the thigh but they are much less extensive than these latter. In the most advanced postnatal development of the human type the humerus can be raised to the side of the head (ear) without acting upon the thoracic cage spine or abdomen.

A third form of upward and forward rotation of the thoracic cage with similar abdominal involvement is observed in connection with some activities of the diaphragm. This form will be studied in the next chapter on *The experimental development of the splanchnoptoses and their relation to the body form*.

#### SUMMARY

1 The evolution of the human type is not completed at birth. The position of flexion abduction and outward rotation which the lower extremities (thighs) spontaneously assume at term marks a stage in their evolution from an earlier biological position towards the advanced postnatal human position of extension adduction and inward rotation so that the patellæ look forward.

2 Similarly the upward and forward rotation upon a transverse axis of the thoracic cage observed at term when the upper extremities are raised either in front or at the side so that the humerus approaches the side of the head (ear) marks a stage in the evolu-

tion of these extremities from an earlier biological position toward the advanced postnatal position in which the humerus can be raised to side of head (ear) without acting upon the thoracic cage spine or abdomen.

3 The human prenatal and at term positions of both the upper and the lower extremities have demonstrable functional advantages in sub human types of animal life but persistence of these positions in the human being indicates retarded incomplete or reversible evolution of the individual in these directions. Tendencies toward this persistence are always present until the advanced evolution of the body form is attained. Even when attained this body form tends to be more or less unstable according as one or the other of two instincts is the more dominant. The instinct toward the more advanced postnatal type of body form is manifested most largely through the agency of the muscles (as well as the viscera) the instinct toward the conservation of the more primitive prenatal type is manifested most largely through the agency of the fibrous tissues (as well as the viscera) which are relatively short along lines made strong by older biological paths. Whenever the muscle instinct lags or is obstructed the fibrous tissues instinct tends to assert itself the more markedly movement then being in the direction of reversion toward earlier (prenatal) forms.

4 The at term position of the lower extremities is due to firm contractions (relative shortness) of certain of their deep fibrous tissues and the connections of these fibrous tissues with those of the pelvis and lower spine and through these latter with the more cephalad parts of the body.

5 Changes in the developing positions of the lower extremities and their connections are intimately related to modifications of the body form particularly with reference to all abdominal walls (anterior posterior lateral superior and inferior) as well as to modifications of the positions of the contained viscera in the direction of splanchnoptoses.

6 The abdominal walls are thus so intimately coordinated with the spine the pelvis the thorax the upper and the lower extremities and even the head that some

study of all the latter is necessary to an understanding of the former

7 As the advanced postnatal position of the lower extremities (thighs) in the direction of extension adduction and inward rotation so that the patella look forward is experimentally developed at term in the supine position the following changes in the body form occur synchronously the trunk thigh lateral angle disappears and the whole trunk appears to narrow and elongate the pelvis rotates downward and forward on a transverse axis and the symphysis pubis descends the lumbosacral region arches forward in marked anterior convexity this anterior arching may involve the lower thoracic spine and then upward and forward rotation of the thoracic cage upon a transverse axis is added the abdominal cavity is contracted from behind forward by the throwing forward of the lumbosacrothoracic and the iliac regions and it appears narrowed from side to side especially in the region of the loins the viscera are thrown forward and downward causing increased stress upon the anterior and anterolateral walls which are lengthened by the descent of the symphysis (and perhaps also by the ascent of the thoracic cage) while the back appears shortened by the increased lumbosacrothoracic posterior convexity The relations of the femur are changed so that it is now convex forward instead of forward and outward the outer surface of the great trochanter looking backward and outward instead of backward modeling of the trunk pelvis thighs legs and feet develops The legs describe a slight curve with the concavity medially instead of forward and inward and the feet continue the curve of the tibia causing supination of the feet with a tendency of the forward part of the feet to overlap

8 At term the supine position reveals four anteroposterior spinal curves two organic (the lumbosacral and the sacrococcygeal) and two functional (the cervical and the thoracic)

9 The cervical anterior convex curve is developed as a result of the struggle between (a) the instinct to bring the face into the frontal plane and (b) an acquired forward inclination or flexion of the cervical or cervicothoracic spine The earliest postnatal factor

moving toward the development of a cervical anterior convexity is interference with the backward projection of the occiput dorsad to the spine by bringing the occiput to rest upon the same plane as the trunk or upon a more anterior plane as in the ordinary assumption of the supine position thus producing a forward inclination or flexion of the more anteriorly attached cervical or cervicothoracic spine This factor is present even when the head is flexed but its action increases as the head is extended When the occiput is given free play to find its normal position dorsad to the spine the cervical spine remains straight whether in flexion or extension The straight and the curved cervical spine assist respectively in the elevation or depression of the thoracic cage

10 The experimental evolution of the lumbosacral anterior convex curve may at term be developed retrogressively along two paths and it seems to show that this curve apparently develops as the anterior body concavity of the embryo straightens with extension of the spine and that it apparently becomes fixed as the pelvic bones become attached to the spine and to each other

11 Progression toward the development of the advanced postnatal position of the lower extremities assists in modeling of the pelvic cavity and the lower spine this modeling being similar in the two sexes The pelvis is constantly in a condition of unstable equilibrium so its angle of inclination its axis the contents of its cavity and its relations as the floor of the abdominal cavity are continually shifting more or less

12 The upper extremities and the head modify the body form largely through the spine and through their action upon the tendency of the thoracic cage toward rotation upon a transverse axis

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PERIOSTEAL TRANSPLANTS IN THE REPAIR OF DELAYED UNION UNUNITED FRACTURES, AND LOSS OF BONE SUBSTANCE<sup>1</sup>By HARRY F. MOCK, M.D., F.A.C.S., CHICAGO  
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A YEAR ago I presented a paper before this society on the value of periosteal grafts in the repair of delayed union ununited fractures and loss of bone substance. The practical application of the method as shown by some 10 clinical cases presented was lost sight of in the prolonged discussion relative to 'How Does Bone Grow?'—a controversy almost two centuries old in the age of modern surgery and undoubtedly a favorite bone of contention among the ancients.

In SURGERY, GYNECOLOGY AND OBSTETRICS the official organ of the College of Surgeons one finds so many articles on the experimental studies of bone regeneration that the student is soon lost in the maze of conflicting statements. Reviewing this journal from its last issue back to January 1911 one finds at least a half dozen articles dealing with this controversial subject. Other journals especially the German and French are replete with similar articles.

S. F. Haas (4) quoting Keith gives an excellent review of the theories and beliefs held by many investigators down to the present time. As a result of his own experiments Haas ascribes the greatest osteogenesis to the periosteum, a certain amount of osteogenesis to the endosteum—an ability to form new bone cells but lacking the power to cement together the fractured fragments—and very little if any osteogenesis to the cortex when stripped completely of its periosteum and endosteum.

Since Haas' publication, Carl Rohde (7) of Freiburg, Germany, has published an exhaustive experimental study of 'How Does Bone Form?' He found three sources of osteogenesis, namely, the chief source from the cambium or inner layer of the periosteum, the next source from the endosteum, and a certain amount of regeneration from indifferent mesenchyme cells lying near or in the connective tissue surrounding bones. (He

ascribes bone formation in remote tissues of the body as in the abdomen in scars in the heart muscle etc. as due to these indifferent mesenchyme cells lying in adjacent connective tissue which through trauma, infection, toxic stimuli or metabolic disturbances abandon their indifferent stage and begin to build bone.) He feels that he has proved the ability of connective tissue cells to undergo a metaplasia. He gives as a law the following:

*Fundamental prerequisites for bone formation are living osteoblasts or unused remaining mesenchyme cells which can develop into osteoblasts.* These bone building cells, living osteoblasts, take from the living organism the organic and inorganic substances needed for bone building.

Rene Leriche and Albert Policard (5) of Strasbourg and Lyons, France, have published an exhaustive study entitled 'The Problems of the Normal Physiology and Pathology of Bones' (Paris: Masson et Cie, 1926). In a short article (6) in September 1926 they reviewed their conclusions and here we have a new element injected into this very old controversy. They state emphatically: 'The periosteum has no true osteogenic action. It checks osseous infiltration which spreads widely. (The old limiting membrane theory for periosteum.) They continue:

The periosteum does not cover an osteogenic layer with numerous osteoblasts. This conception is purely a theoretical one. It becomes necessary only if an indispensable and fundamental part is given to the osteoblasts. But when the periosteum is modified by a change of circulation or by oedema it becomes then a ground for ossification. It is passively ossified—it does not make bone in an active manner.

The formation of bone is a result of the metaplastic change in the connective fundamental substance. This metaplasia takes place in three ways: (1) transformation of the connective tissue by an oedematous infiltration with a multiplication of connective fibrils; (2) infiltration by a special substance chemically undefined—the pre-osseous substance.

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They further dc ribe the characteristic changes in bone in the neighborhood of fractures which we have heretofore ascribed to atrophy from disuse and state

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Contrary to this last statement we have the conclusions of Allison and Brooks (1) in an article on Bone Atrophy to the effect that non use of an extremity resulting in bone atrophy has no effect upon the regeneration of bone at the site of bone defect They showed that bone atrophy caused no increase in the amount of organic or inorganic salts and concluded The proce of bone atrophy is not a change in the characteristic of bone as a sub tance It is a change only in the amount of bone present The chemical composition remains unchanged

Thus the problem of how bone regenerate following a fracture or loss of continuity is still a muted one In reviewing the literature and in following his own experimental work one is impressed with the similarity of all animal experimentation on the subject and the efforts of most investigators to prove or disprove the limiting membrane theory of periosteum the presence and location of a cambium layer and the presence of or lack of osteogenesis in one or all of the three bony layers

The recent work of Leriche and Policard is a notable exception to past investigation While their conclusions may not be accepted yet they should serve to stimulate others to attack this problem from the functional physiological and chemical standpoints

As a result of all these years of experimentation by many investigators and the practical application of certain methods by various surgeons the autogenous bone graft has become a fixture in bone surgery At first only the cortex was transplanted and we can readily understand the contentions of Murphy and others that this graft served

only as a bridge the graft itself dying and being replaced by new bone growing out across this bridge from the ends of the fragments Cortex alone has very little osteogenesis

Later Albee Lewis Phemister Cotton and a host of other surgeons advocated the use of all three layers in the bone transplant periosteum cortex and endosteum Reports of their result combined with animal experiment seemed to prove conclusively that uch a graft lived We know from experience that it repaired the defect in a bone caused by ununited fracture the removal of a tumor or other cause

However without exact knowledge as to how the bone regeneration occurred or which layer of the graft was responsible for its viability and osteogenesis the practical result of reconstruction of the bony defect in the skeleton was secured Those of us who have used this graft know its value

Delaguerre (3) opened a new chapter in bone surgery with his report of results in the use of the osteal periosteal transplant He describes his technique for an implant to promote regeneration of bone It is not a graft but merely supplies the elements indispensable for formation of bone He declares that contrary to what Albee says it is possible to reconstruct any part of the skeleton and cure any pseudoarthrosis and obtain the desired results in a simple effectual and more certain manner than with Albee grafts He obtained excellent and complete results in 244 of his 73 cases The graft should consist of the periosteum lined throughout with a thin layer of bone The bone strengthens the transplant holds the periosteum stretched and keeps it in good shape to facilitate the reconstruction of the bone A tibia can furnish about 22 centimeters of such transplants His illustrations show how he rolls up a rectangular graft on the periosteum side to insure a proper curve to fit in its new bed The bone periosteum strips are implanted side by side end to end and overlapping the bone side toward the bone bed The edges are slipped under the periosteum all around When an angular space is to be filled in he ties two sheets together at an angle the

flaps are kept in place by suturing the soft parts

Goodwin in 1800 first ascribed osteogenesis to periosteum Ollier in 1857 described the subperiosteal resection of diseased bone showing that the repair of the defect occurred from the retained periosteum Albee was one of the first to insist that periosteum must be included in the bone graft Haas and later Rohde in their experiments attributed the chief osteogenic ability to periosteum Delageniere emphatically claims that his osteal periosteal transplant is superior to the bone graft because it contains more of the periosteum the element indispensable for bone formation

Leriche and Policard refute this claim of active osteogenesis in the periosteum but state that the periosteum is modified by change of circulation or oedema and thereby becomes the ground for ossification—it is passively ossified

The outstanding fact in this resume is that *to periosteum alone of all the bone layers is ascribed a definite role in bone regeneration*

In addition to this uniformity of opinion concerning some power in the periosteum for bone regeneration I have repeatedly observed the following facts which give additional weight to the argument in favor of periosteal osteogenesis

1 When the bone is exposed at operation for old ununited fractures the cortex is roughened and completely denuded of periosteum for a distance on either side of the site of fracture The ends of the fragments may be osteoporotic or osteosclerotic but in either event periosteum is absent for a variable distance from the ends of the fragments

2 In cases of delayed union of fractures following severe trauma or trauma from repeated efforts at reduction which are finally operated the periosteum is very thin almost impossible to ruse without tearing and shredding and ofttimes has completely disappeared from the ends of the fragments

3 In the application of a Lane plate in a recent fracture say within the first 2 weeks the results are far better than when a Lane plate is used in a case of delayed union or an

ununited fracture In the latter case the plate is usually applied to a bone with very poor periosteum or one completely denuded of it

4 Subperiosteal resection of ribs phalanges metacarpal and metatarsal bones for osteomyelitis other than tuberculous almost uniformly results in regeneration of the bone evidently from the retained periosteum When the periosteum is completely removed with the bone proper this regeneration does not occur or is greatly delayed

5 We have sacrificed 8 dogs in the last year in an endeavor to secure regeneration of bone across gaps of varying lengths by means of a pure periosteal graft In dogs the periosteum is so thin that it is almost impossible to raise it without shredding providing no cortex is left adherent to it Thus far we have not succeeded in closing in this bony defect with a periosteal transplant in a single instance We have found however that when we completely denude the bone of periosteum for a distance of 3 to 4 centimeters on either side of a transverse fracture or from the ends of the fragments in the case of the removal of a small section of the entire bone non union results The absence of periosteum at the site of and adjacent to the fracture resulted in non union in 6 cases examined from 3 to 6 months after this operation In 3 of these cases bone regeneration had commenced but in each instance it was at the margin of the periosteum and not at the ends of the fragments (Fig 1)

From these observations and from the clinical cases about to be reported the following conclusion is justified *Periosteum is necessary for the regeneration of bone and therefore in cases of delayed union ununited fractures and loss of bone substance periosteal transplants when properly fitted about the site of the damaged bone will result in healing and reconstruction of the defect*

In making this statement I do not claim that periosteal transplants are superior to the osteal periosteal transplants in all cases nor to the generally recognized autogenous bone graft in certain cases I believe in many instances a certain amount of cortex removed with the periosteum is advantageous chiefly

because it gives strength shape and foundation to the transplanted bone. I believe further that in the larger bones where there is a considerable loss of continuity the osteal periosteal transplant or the autogenous graft is superior to a pure periosteal transplant. But in these cases I will in the future remove as large an amount of periosteum as possible with the bone graft.

Periosteum alone of all the three layers of bone has received the majority of votes of all investigators as being the one layer most indispensable in osteogenesis. Bearing this in mind let us evaluate the various kinds of transplants and grafts.

#### A Cortical graft

1 Of the least value because it contains no periosteum.

2 It serves chiefly as a means of internal splinting but as such is superior to any inorganic or heterogeneous internal splint.

#### B Autogenous bone graft

1 Of more value because it contains some periosteum.

Because of the narrow strip of periosteum which this graft usually contains it is of less value than the method which transplants larger amounts of periosteum.

3 The cutting and transplanting of this graft requires more time a much more cumbersome technique and considerably more trauma than either the osteal periosteal or periosteal transplants.

4 Its one advantage over the latter two transplants is that the solid cortex contained in this graft furnishes an excellent means of internal splinting or fixation of the fragments a point of special value where there is a wide loss of continuity.

#### C Osteal periosteal transplants

1 Of great value because wide strips of periosteum can be removed with a thin layer of cortex.

Such a transplant can be removed more quickly and planted in the bony defect with far less technical difficulties than either the cortical or full bone graft.

3 It is superior to a pure periosteal graft only in those cases in which a loss of bone substance makes it necessary to hold the periosteum more firmly and in a given shape

for example in the form of a cone or a wide plate.

4 It reconstructs the defect in the bone more rapidly than is the case with the usual bone graft—because of the presence of a greater amount of periosteum.

#### D Periosteal transplant

1 Of great value because of the large size of the transplant which can be removed a much larger piece of periosteum than the narrow strip usually adherent to the autogenous graft.

It can be removed with a blunt instrument stripped off readily and more quickly than either the osteal periosteal or full bone graft.

3 Because of its thinness it can be wrapped about tucked in and brought into the closest apposition with the bone fragments to be repaired.

4 It can overlap the ends of the fragments and be sutured to the edges of the periosteum remaining on the bone often at a considerable distance above and below the site of bone defect.

5 There is far less trauma to the bone from which a periosteal graft is obtained than when a complete bone graft is made. The healing of this additional wound is quicker and less painful.

6 The technique of a periosteal transplant is much simpler can be performed far more rapidly and there is less operative trauma to the already damaged bone especially to its adjacent periosteum which is frequently peeled off and markedly destroyed because a greater amount of the shaft must be exposed in doing a complete bone graft especially a sliding graft.

7 In my hands it has given quicker reconstructive results than have my cases of autogenous bone graft. I cannot thus far see any material difference between it and osteal periosteal transplants as to rapidity of repair. I begin to believe that the latter has the advantage when there is a loss of bone substance.

We know autogenous bone grafts are a success. We know that osteal periosteal transplants are a success and are receiving more and more favor as a simpler procedure.

The chief reason for continuing the use of pure periosteal grafts is to prove or disprove their value and if they continue to prove successful then they surely form the simplest method yet devised for the repair of delayed union and of ununited fractures except perhaps those with marked loss of bone continuity

#### CLINICAL OBSERVATIONS OF PERIOSTEAL OSTEOGENESIS

Animal experiments often fail to give the true counterpart of similar conditions in the human body. It would seem therefore that for practical surgical purposes carefully recorded observations of our experiences with bone work in the human should receive the greater consideration in arriving at our conclusions. With this in mind I wish to report my clinical experiences during the last 4 years with periosteal grafts leaving certain experimental problems which have grown out of the work to be reported at a later date.

In 1912 I operated on a young lady for a bone cyst of the proximal phalanx of the fifth finger. In the freeing of the soft tissues from this bone shreds of the periosteum were peeled off also. The entire diaphysis of the phalanx was then removed and the defect was filled in with a cortical bone graft taken from the tibia. The transplant was composed only of cortex. Subsequent X ray examinations made at intervals of 2 to 3 weeks showed bony regeneration occurring first along the inner margin of the transplant *but separated from it*. There was no question but what the new bone was growing from remnants of the periosteum and not from the cortical bone transplant. The latter showed no evidence of bone regeneration but finally became fused with the new bone growing inward from the periosteum.

This same year I resected the upper end of the humerus for bone cyst with pathological fracture in a boy of 17 years. The defect was bridged with a 6 inch bone graft from the tibia. This time I carefully included periosteum, cortex and endosteum in the graft. Frequent X ray observations showed bone regeneration but most marked and first noted along the periosteal side of the graft and espe-

cially between the periosteum of the host and periosteum of the graft.

During the next few years I had several cases of autogenous bone grafts in ununited fractures after removal of bone tumors in repair of skull defects and in certain plastic operations on the nose. In spite of infections fracture of the grafts and the usual complications the average surgeon in bone work meets union in all cases was obtained but often months and in one case 7 years elapsed before the desired end was gained. Observation and experience taught 3 things: first quicker results were obtained when periosteum was included in the graft; second the larger the amount of periosteum transplanted the earlier did a large amount of callus form; and third in many cases of old ununited fractures the bone fragments were sclerosed and completely denuded of periosteum and in these periosteum as a part of the transplant was absolutely necessary.

Subperiosteal resection of a portion or of the entire shaft of a bone the seat of osteomyelitis has been advocated by a few authors since Ollier first described this procedure in 1857. Bauman and Campbell (2) give an excellent report of this procedure in a number of cases and conclude that regeneration of the shaft takes place from the retained periosteum; that the role of the endosteum in the regeneration is slight and that success can be obtained in all but about 10 per cent of cases other than tuberculosis. I have performed subperiosteal resections for pyogenic osteomyelitis of the phalanges, metacarpals and metatarsals in over 50 cases, also in several cases of the larger bones. The periosteum often in shreds is carefully peeled away from the diseased bone with the surrounding soft tissues. The length of the member is maintained by traction. Following this procedure the regeneration of the diaphysis of the bone can be observed by repeated subsequent roentgenograms. The first picture will show a complete absence of bone while the subsequent films show the gradually increasing shadow of bone growing in from the retained periosteum. This periosteal regeneration of bone stimulated undoubtedly by the infection and over rich in osteoblasts because of



the early stages in involucrum formation nevertheless demonstrates for practical purposes the great osteogenic properties of periosteum.

My experience with operating upon recent fractures is limited and is becoming less extensive each succeeding year of practice. A review of the records of the last 300 cases of recent fracture admitted to my service at St. Luke's Hospital shows that in only 31 cases have open operations been performed. Experience teaches one to be content with a fair anatomical result rather than to seek for a perfect alignment of the fractured fragments as shown by the X-ray picture. The latter desire necessitates more frequent operation, the former eliminates open reductions, and in the end gives quicker and more uniform good results.

When a recent fracture is operated upon there is added to the original trauma the operative trauma. The original trauma has already done considerable damage to the periosteum as is shown by the oedema, hemorrhage and bredding of the periosteum. The operative trauma can add markedly to this damage. Frequently we see the bone completely denuded of periosteum during the act of exploring the site of fracture and after reduction and some means of fixation have been applied the wound is closed with the site of fracture still denuded of periosteum. This to my mind is the chief reason for the longer delay in securing union in open reduction of fractures and accounts for the greater number of non union cases following operation as compared with closed reductions. Repeated efforts at closed reductions in the same case will likewise frequently result in non union. Here again the additional trauma is responsible. Just as we have been so thoroughly drilled in the importance of closing the peritoneum before closing the other layers of the abdomen in order to prevent hernia so must we drill the surgeon in the importance of covering fracture sites and bony defects with periosteum in order to prevent non union. Therefore whenever it is necessary to operate upon a recent fracture the site of fracture is now always covered with periosteum after the reduction and

fixation have been attained. This periosteum can usually be obtained from the shaft adjacent to the fracture peeled off by a blunt periosteotome either completely or left attached at the margin nearest the fracture. It can then be wrapped about laid across and tucked in around the fracture site. It can be sutured to the periosteum on the opposite fragment or to adjacent soft tissue in order to hold it in place and sometimes the closure of the soft tissues over the transplant is all that is necessary. Case illustrating periosteal transplant in recent fracture.

CASE. J. A. colored male 22 years of age (case of Dr. Thomas A. Noble of Harvey, Illinois and patient up at Ingalls Memorial Hospital) sustained a fracture of his right femur middle third September 10 1925. There was marked oedema and rigidity of the fragments. A Thomas splint was applied with good mechanical traction for weeks but without result. The patient was then anesthetized and strenuous effort at closed reduction was made but without success. The traction apparatus given up and maintained for 2 weeks but little result obtained. At the end of 4 weeks after the efforts the writer was called to patient up in the case. At operation the lower fragment was found displaced backward and upward (Fig. 1). A band of muscle lay between the fragments which may have accounted for the failure of closed reduction. It required considerable effort to secure separation and apposition of the fragments. They were held in end to end apposition by means of an internal splint consisting of an anteroposterior bar of bone peg. By the time this was accomplished the adjacent fragment were fairly denuded of periosteum. A periosteal transplant was obtained from the right tibia consisting of a piece of periosteum approximately 6 inches long and 1/2 inch wide removed by a blunt periosteal knife. As far as the naked eye could see no blood vessels attached to the periosteum and its method of removal by blunt dissection precluded the removal of cortex. This piece of periosteum as then wrapped around across the anterior surface of the fracture. Figures 3 and 4 show the graft of the periosteum and the part it played in securing rapid union in this case. The patient was discharged from the hospital on December 26 and was walking without a crutch or cane when he left on January 9 1926. Wound made just 3 months after the operation.

The next case illustrates the use of periosteal transplant in case of delayed union. Fewer cases of delayed union are being operated upon than formerly because here again experience is proving that massage passive

motion of adjacent joints and persistence in treatment will usually result in the desired end. Diathermy has seemed to be of value in a number of cases in which callus formation was unduly slow. But we occasionally have a case in which the delay in union threatens to give non union or in which the disability can undoubtedly be shortened by operative interference.

**CASE 2.** Miss DeL., 4 years of age (case of Dr. G. W. Walvoord of South Holland, Illinois) sustained a fracture of the right humerus middle third March 6, 1926. (The middle third of the humerus and the lower third of the tibia are two sites prone to delayed union in my experience.) The case was referred to the author's service at St. Luke's Hospital for operation on May 1, 1926. At operation the site of fracture was exposed and the fragments found to be approximated about one fourth of their circumference. The periosteum on either fragment was practically absent. No sign of callus was present. The fragments were brought into perfect alignment and held thereby with an internal splint of beef bone peg. This peg differed from the usual round peg. It was the author's triangular shaped peg with notches cut in one angular edge which enabled the pushing of the peg from the canal in the upper fragment downward into the intramedullary canal of the lower fragment more readily. A pure periosteal transplant was then removed by blunt dissection from the right tibia. This transplant 4 inches long and 1 inch wide was laid across the anterior surface of the humerus at the site of the fracture and sutured to the periosteum where it was intact on the humerus about 2 inches either side of the fracture. The interesting fact in this case is the development of new bone along this transplant so that the callus forms an arch over the site of fracture but no evidence of callus is present on the other surface of the humerus even 10 months after the operation was performed. In February, 1927, the X-ray examination shows this fracture united on the surface where the transplant was applied but still ununited on the opposite surface. Examination shows good strength even with this half union that is present. I believe this case is most valuable in proving the development of new bone from a pure periosteal transplant. A better and perhaps more rapid result would have followed the complete surrounding of the humerus at site of fracture with the periosteal transplant (Figs. 5 and 6).

Better results from this method have been obtained in cases of ununited fractures than by any other method heretofore employed by the author. Thus far 30 cases of ununited fractures have been treated with or without internal splinting. In all of these cases union

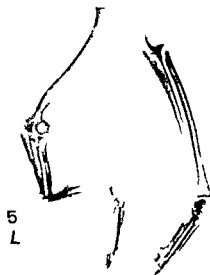
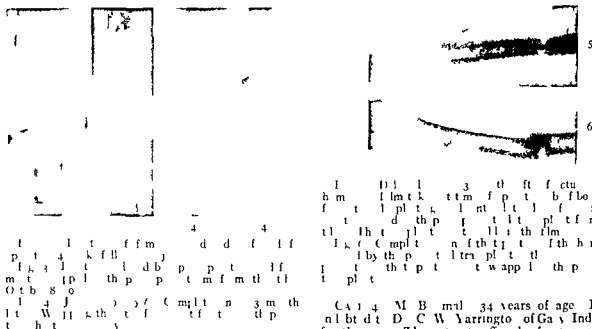


FIG. 5. Non union in dog, 3 months after operation. Fracture in which periosteum was stripped from end of fractured fragments. Note the bone regeneration occurring from the margin of the rolled up periosteum on the distal fragment and growing across the angle to unite with the proximal fragment.

has resulted. In one of the cases the beef bone pegs had to be removed later because of persistent infection and in one case the peg was removed because absorption of the shaft of the bone was threatening the desired end result. Latterly I have abandoned this method of beef bone peg internal splinting except in rare cases as will be explained later and the results are better.

**CASE 3.** S. G. male, 5 years of age was referred to my service for operation for ununited fracture of the radius in November, 1924. He had been operated on by another surgeon some 8 months previously at which time a beef bone peg was inserted in the intramedullary canal of the 2 fragments. This operation was performed 8 weeks after injury for delayed union. The X-ray picture taken at the time the case first came to my attention showed this peg in position but no evidence of union. At operation the site of fracture was exposed and the fragments of the radius were found completely denuded of periosteum. The ends of the fragments were found osteosclerotic above and osteoporotic below. The beef bone peg was holding the fragments in alignment and it showed very little evidence of absorption. The operation consisted of cutting away the ends of the fragments back to where fairly healthy bone was present. The peg was left *in situ*. The shaft of the upper portion of the radius was then exposed more thoroughly and from this a piece of periosteum about 1 inch wide and 3 inches long was raised by blunt dissection downward almost to the end of the upper fragment.



It was a flap of the periosteum turned simply turned down and placed as a flap for the purpose of closing the gap in the bone and to the periosteum on the lower fragment. By this maneuver the transplant as far as its upper end attached and secured as a hinge at its lower end and then turned downward the inner circumference of the periosteum of the shaft of the ulna of the periosteum of the bone.

In the discussion aroused when this paper was presented some doubted if periosteum turned upside down would grow bringing the old limiting membrane idea of periosteum to refute my claim. This maneuver has been repeated in other cases with the result that the periosteum does grow and even bridges across a bone defect. These cases make me feel that another law can be added to Wolff's law namely *New bone develops along the path decreed by the bone it is to replace and by the function demanded of it*. No limiting membrane is necessary to prevent new bone growing wild or in any other direction than that demanded by the body function.

The subsequent X-ray pictures taken of Case 3 (Figs 7, 8 and 9) show definitely that new bone development started along the upside down periosteal transplant and resulted in reconstructing completely the shaft of the radius.

Case 4: M. B. male, 34 years of age. I am indebted to Dr. C. W. Yarrington of Gary, Indiana for this case. The patient suffered a fracture of the upper end of the right radius and ulna 3 1/2 inches from the elbow joint in October 1914. The result of a street car accident. There was marked over-riding of the fragments and after an attempt at closed reduction open reduction was attempted. At the end of 4 months there was non union and the case was re-operated upon the end of the fragment being held in apposition by silver wire through drill holes on the radius and by kangaroo gut on the ulna. Non union was still present at the end of 6 months and the case was again operated upon the silver wire being removed the fragments freshened and held in apposition by suturing of the soft tissue. Thirteen months after the injury the case was referred to me as one of nonunion fracture.

An operation was performed at St. Lukes Hospital, New York, November 3, 1915. Operation consisted of the exposing of the site of fractures by incisions. Both the fragment of the radius and ulna were removed completely and the periosteum of the upper fragment of both bones were lying in close proximity and were exposed. The lower fragment of both the ulna and radius were placed out and the osteoclastic especially in the ulna and were prepared from their flaps by a distance of approximately 1 inch. The iliac crest was then the fragment of the radius still evident. There was absolutely no bone in the fibrous material typical of nonunion lay between the fragments.

The ends of the fractured bones were removed leaving a space of approximately 2 inches between the fragments of the radius and 1 inch between the fragments of the ulna. The medullary canal in both bones were prepared and a beef bone plug inserted into each upper fragment. The ends were worked down into the medullary canal of the lower fragment thus bringing the shafts into alignment.

ment and serving as internal splints. A small fragment of loose bone was found on the posterior aspect of the lower fragment of the radius and this was left in place. The right tibia was then exposed and a periosteal transplant the complete width of the tibia and approximately 5 inches long was removed by blunt dissection. A piece of fascia approximately 1 inch wide and 5 inches long was removed at the same time and left attached to the outer border of the periosteal transplant thus forming a transplant composed of pure periosteum and fascia. This transplant was carried to the defect in the radius. The fascia was first sutured to the soft tissues in such a way as to form a fascial septum between the ulna and the radius. The periosteal portion of the transplant was then wrapped around the radius forming a bridge across the defect and covering about two thirds of the circumference of the radius. It was sutured above to soft tissues in close apposition to the bone and 2 sutures were applied below approximating it to the periosteum on the lower fragment.

The left tibia was then exposed and a similar periosteal transplant devoid of fascia however was removed by blunt dissection no cortex being obtained and was transferred to the defect in the ulna. This transplant covered approximately one half the circumference of the ulna and bridged across the defect in this bone. While an assistant was closing the operative wounds in both lower extremities the soft tissues were closely approximated about the repaired fractures in the ulna and the radius and the wounds were closed. The arm and forearm were encased in a plaster splint with the forearm flexed to approximately a right angle. Figures 10 and 11 show these fractures before the operation and 1 week following the operation. The progress of this case is illustrated by the subsequent roentgenograms (Figs. 12 and 13). Union was slow because of the marked loss of bone substance in each bone which had to be filled in by new bone before union could occur. I believe that the progress was also delayed by the presence of the beef bone pegs which (Figs. 1 and 13) caused considerable absorption of the cortex immediately adjacent to the pegs. Massage passive motion and hydrotherapy were used continuously on this arm after the eighth week great care being exercised not to disturb the fragments unduly.

On October 1 1916 union seemed quite firm although the roentgenogram failed to show complete filling in of the defects. The splint was removed and the patient allowed to use the arm very slightly with the hope that function would stimulate further and more rapid growth of new bone. After 3 weeks it became evident that there was some false motion in the ulna. This was demonstrated by observing the arm under the fluoroscope. On November 12 1916 I reoperated upon this case making an incision over the site of the fracture in the ulna. On the lateral posterior surface of the ulna there was a definite bridge of new bone com-

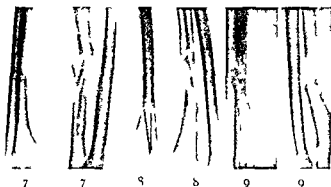


Fig. 7 Ununited fracture of radius operated on November 3 1924 film taken November 30 1924 showing periosteal transplant removed by blunt dissection from the proximal fragment and turned downward as an oblique bridge the 1 inch defect in the bone thus the periosteal transplant as upside down the inner layer pointing outward. The internal splint is a beef bone peg placed in the medullary canal 8 months previously.

Fig. 8 Same case as in Figure 7 6 months later. Note the thickness of the periosteal transplant showing that all of the regeneration has taken place in the transplanted periosteum.

Fig. 9 Same case as in Figure 7 showing the completed reconstruction of the defect in the radius.

pletely across the defect but on the upper and inner surface no new bone was present and the beef bone peg lay in its bed completely exposed and easily movable. The radius was palpated through this wound and was found to be surrounded by a good callus and quite firm. The beef bone peg in the ulna was removed. The left tibia was again exposed and was found to be covered with a thick velvety periosteum which was thicker and richer in blood supply than the original periosteal transplant taken from this tibia. An osteal periosteal transplant the width of the tibia and 4 inches long was removed by blunt dissection along its lateral edges but by a chisel along its middle thus removing a thin piece of cortex with the transplant. This transplant thus consisted of an osteal periosteal graft with osteal substance along the middle of the transplant approximately  $\frac{1}{8}$  to  $\frac{1}{4}$  inch in thickness and pure periosteum along the margins. This was transplanted to the defect in the ulna the osteal portion lying in the groove made by the removal of the beef bone peg and the periosteal portion wrapped about the upper and inner surface of the ulna. It was held in position by a few sutures in the soft tissues and to the periosteum on the fragments above and below. Figures 14 and 15 represent the growth of this osteal periosteal transplant and the subsequent repair in the defect in the ulna. The plaster splint was removed on December 27 1926 and the patient was discharged with the ununited fractures completely healed and united on January 10 1917 14 months after my original operation for repair of non union in these bones fractures which had gone 13 months before this treatment was instituted.



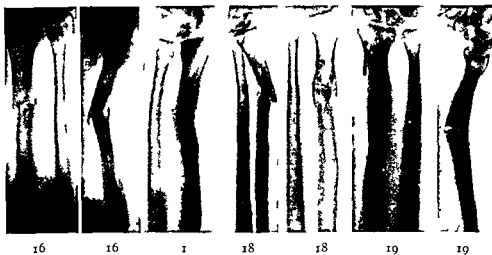


Fig 16 Ununited fracture of radius of 3 years duration. Operation. Lane plate removed. fragments adjusted and strip of periosteum removed by blunt dissection from the proximal fragment and turned downward across the site of the fracture forming a periosteal bridge chiefly along the lateral surface. First film as taken 1 week after operation.

Fig 17 Same case as in Figure 16 taken 16 days after operation. Note the growth of the periosteal transplant.

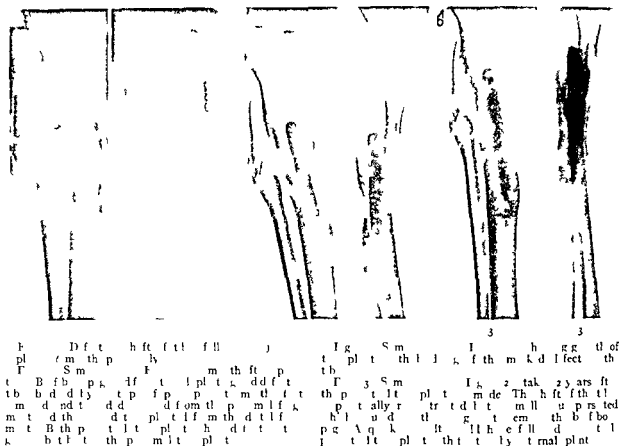
Fig 18 Same case as in Figure 16 6 months after operation. The periosteal transplant has fused with the shaft. Note that the regeneration of this bone is best at and near the transplant.

Fig 19 Same case as in Figure 16 showing a green stick fracture at this site 11 months after operation for ununited fracture. Note that the new bone along the lateral margin where the periosteal transplant was applied is the only portion of the shaft not refractured.

could be easily demonstrated. The case was brought on September 27, 1935 to Chicago but as the original surgeon had moved to another city, the boy was entered on my service at St. Luke's Hospital. At operation one of the screws from the Lane plate was found lying in the soft tissues and the other screws loosened up so that the plate was easily removed. The fragments below the plate and about the site of the fracture were denuded of periosteum. The ends of the fragments were osteoporotic. This softened bone was removed thereby freshening the ends of the fragments. They were in very good alignment and no effort to change the alignment was made. The shaft of the radius above the site of the fracture was exposed and a strip of periosteum was removed by blunt dissection and turned down across the site of the fracture. Great effort was made to secure an abundance of periosteum across this defect in the bone and some of the strips were therefore turned down so that the cambium layer pointed outward. The anterior surface of the bone alone was covered however. Figures 16, 17, and 18 show the rapid healing which occurred in this old fracture. From the findings at the time of operation this was definitely an ununited and not a recent fracture. The fracture had never united under the Lane plate. The boy was discharged 10 weeks after the operation with firm union.

Since writing the foregoing we have had an extremely interesting additional observation in this case. On September 8, 1937 while playing ball

the patient fell striking on his extended right hand. He immediately felt pain at the site of the old fracture and observed an angulation deformity. Swelling of the forearm rapidly followed. He was again taken to Dr. De Witt of Valparaiso, Indiana who examined the arm with the X-ray and diagnosed a fracture at the site of the old fracture. He was sent at once to my service at St. Luke's Hospital. Examination showed a slight angulation, slight swelling and point of moderate tenderness directly over the site of the old ununited fracture described above. Study of the roentgenogram which he brought with him and of a second film taken 3 weeks later (Fig. 19) showed the following: There is a line of fracture through approximately two thirds of the shaft of the radius resembling a green stick fracture. The unfractured portion of the radius consists of one third of the lateral portion of the cortex where the periosteal transplant was placed across the site of the old fracture just 11 months previously. This unfractured portion shows strong healthy bone but slightly bent. The margins of the fragments of the fractured portion and the shaft above and below this fracture are somewhat osteoporotic and you can still see 2 drill holes used for the Lane plate 4 years ago. In other words firm union of this old ununited fracture resulted along the anterior margin where the periosteal transplant was laid but that portion of the shaft which was not covered by the transplant showed poor osteogenesis.



This case as well as Case (Figs 5 and 6) demonstrate conclusively that a pure periosteal transplant containing no cortical bone substance whatsoever will grow and form new bone. Study of the roentgenograms shows that this new bone involves the cortex immediately under the periosteal transplant; however, in the portion of the shaft not covered by the periosteal transplant, new bone did not grow so that there was a partially ununited fracture of the shaft. I have not observed this condition in any of the other cases, yet the two cases enable us to arrive at the following conclusions:

1. The periosteal transplant will form new bone, but it may be limited only to that portion of the shaft covered by the transplant.

2. To insure complete union in an ununited fracture, at least two thirds of the shaft at the site of fracture should be covered by the periosteal transplant.

3. More rapid and more complete healing of the ununited fracture will result if the

shaft at the site of the fracture is completely surrounded by periosteal transplant.

**CASE 6** J. T. male of Beloit, Wisconsin, 38 years of age. In March 1923 this patient was in an airplane and suffered a severe compound fracture of the upper third of the right leg. The soft tissues were badly lacerated and a fragment approximately 3 inches long was blown from the shaft of the tibia at the junction of the middle and upper third. Considerable doubt existed as to whether the leg should be amputated. The writer was called to see the case a few days later and agreed with Dr. Benjamin Fosse that his treatment of debridement followed by the Carrel-Dakin method of irrigation was justified and might result in saving the limb. A very marked infection developed which persisted for weeks. Eight months elapsed before we felt it was safe to attempt repair of loss of bone substance in the tibia. Figure 20 shows the condition of the tibia at that time.

On April 3, 1924, the author went to Beloit and operated upon this case with Dr. Fosse. Operation consisted of freshening the upper fragment of the tibia and of cutting away the osteoarthrotic portion of the lower fragment of the tibia. This left a gap of approximately 2 inches to be filled in. A dog's chaw sticks were still present from the wound in the



FIG. 4. Unreduced comminuted fracture of the tibia and fibula operated upon 5 weeks after injury. Operation fracture reduced and held in alignment by beef bone peg intramedullary splint the fracture site then covered by periosteal transplant removed and turned downward from the proximal fragment of the tibia.

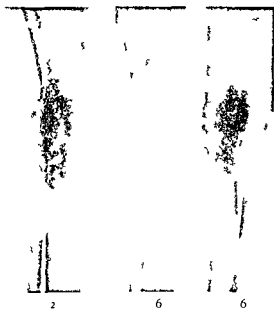


FIG. 5. Same case as in Figure 4 showing the repair of the fracture and almost complete absorption of the beef bone peg 5 months after operation.

FIG. 6. Same case as in Figure 4 taken 10 months after operation. Patient has been working for 5 months complete restoration of function.

soft tissues and therefore a complete removal of old infected tissue in the neighborhood of the fracture was made at this time. A beef bone peg was inserted in the medullary canal of the lower fragment of the tibia and worked upward into the medullary canal of the upper fragment thus forming an internal splint which held the tibia in proper alignment. Next a strip of periosteum 3 inches long and the entire width of the upper fragment of the tibia was removed by blunt dissection downward but left attached at its lower margin and turned as on a hinge downward over the defect in the tibia. Strips of periosteum were next removed from the anterior surface of the lower fragment of the tibia and were laid across the defect. Soft tissues were closed over the defect as well as possible but complete closure could not be secured because of the amount of tissue which it was necessary to dissect away because of the old infection.

Patient made a slow but progressive recovery and the growth of new bone from these periosteal strips is well illustrated in Figures 20, 21, 22 and 23. The soft tissues closed over the area except for one small persistent sinus. Solid union had occurred in this case by January, 1926—1 year and 8 months after the operation. At this time the sinus would remain closed for a few weeks and then would open but with very little discharge. Since the patient was at work and was getting along very well it was my judgment that this condition should be left alone for at least 6 months more fearing a recurrence of the infection if another operation was attempted too soon. In June, 1926 however I was called in consultation on this case by the insurance company with another surgeon of Chicago. This surgeon

felt that the case should be reoperated upon at once and the beef bone peg removed. A week later I was told that this surgeon had removed the beef bone peg. I have learned that the old fracture showed good union but that the beef bone peg was lying loose in the medullary canal with softening of the bone immediately in the neighborhood of the peg. His operation consisted simply of removal of the peg and curetting away the soft portion of bone in the neighborhood of the peg. The wound healed and the patient was discharged from the hospital in 4 weeks. Patient now has good firm union with out any evidence of infection and approximately 75 per cent of function in the knee joint.

Observation of a series of 5 X ray films taken on this case from 3 weeks after my beef bone internal splinting periosteal transplantation to June, 1926 a little more than 3 years after the operation again demonstrates that periosteum will grow and form new bone.

If I were operating upon this case today instead of using the beef bone peg I would use an osteal periosteal transplant as described under Case 4. This case however does illustrate that the restoration of periosteum across the marked defect in this tibia resulted in regeneration of bone and closing in of the defect. It is my judgment that the defect closed more rapidly than would have been the case if I had used a narrow autogenous bone graft containing only a small amount of periosteum. Further the cutting





9 9 U t d f t f d d l a f 8 m th  
d f 3 S m l o t k 3 k f l  
l k p t v k t o 7 O p t f m th t b  
f f k m t p p t l t l t f m th t b  
j l l t t h t f f t l p k l d  
p l t f l l t p p l l t t k p t  
l l l k m t t l p k m d f m th d  
d f m t d j t d h l d t l t h p l t h l d  
t l t h l e l N t t h k t h f t h p t l  
t p l t t h l  
I k 3 S m l O t b 7 9  
S h t h k t h f t h t p l t d l m t  
m j l t

I g D f t t h i t m t t l f t t h j m l  
f k m t m d b f d f m t y l  
t l t p l t f m t t l  
t l k 3 S m l 7 h k t t  
p l t 7 k f t p t

of such bone graft in an area where infection had been rampant a few months before would have made recurrence of the infection more probable

CASE 7 D B m le 45 y old refe d to my s i at St Luke H pital by Dr Nobl H vey Ill nos on N mb r 925 b caus f n un e l u c e d f r a t u of the l f t t i b i a n l f u l a j t b l o w t h m d l l t h l T h i j u r y c u r r d O c t o b 9 9 5 a n d a f f t h a d b e e m a l t o s c u r u o n b t h l o d m t h o l A t p r a t I f o n d t h c k n b r b a n d b t n t h f r a g m e n t s o f t h t b a c o m p d o f i t p o s t g o s t t i s u e n d f i b r o u t s u h a t r i t c o f n u n i o T h i a s c u t a w a y a n l t h e n d s o f t h f a g m n t s f h e t t h a l i g m e n t a d p p o u t n a s m a d b y a n i t m l u l l v b f b p e g u s l a a b o n p l t v p r i t l t r p l a t t h n e m o d f r m t h u p p r p t i o f t h s h f t o f t h t i b i a o n s t g o f t h d t h o f t h t b a a n d a b o t 4 i c h e s l e n g t h a n d s a r e f u l l y r a p p e l a d s t r d a b o u t t h e s t f f a t u e F i g e s 2 4 5 a n d 6 s h o t h s u b s e q u e n t d e v e l o p m e n t o f b o n a n d u o f t h f a c t u n t h s c a s

Six of the cases in which periosteal transplants have been used have been in old fracture of the tibia. In all but one of these I have been able to notch the upper fragment and sharpen the lower fragment in such a way that it fitted into the notch thus giving apposition and a certain amount of fixation without using any foreign material for fixation. The method of external fixation by splinting and by circular band of plaster of Paris described at the end of this article has obviated the need of internal pinning in the majority of my cases. In one of these cases the defect was covered by periosteum secured from the adjacent shaft and fixation secured by Iutti band which were later removed. Whenever Iutti or Parham Martin bands are used great care should be exercised to see that these are applied around the bone outside of the periosteum and not next to the bone denuded of periosteum. In another case in which internal fixation was necessary I chiseled a narrow rather thick piece of cortex from the adjacent shaft to which was attached wider portions of pure periosteum. This

osteal portion formed the internal splint while periosteum furnished the osteogenic tissue

CASE 8 F F male 30 years of age referred on January 17 1927 for reconstructive operation on his foot Eight months previously he had suffered a fracture of the first second and third metatarsals of the right foot These had united but patient complained of severe pain in the sole of his foot when walking or standing Examination showed the proximal portion of the first metatarsal was displaced backward and into the sole of the foot Pain was undoubtedly due to pressure on this displaced proximal fragment At operation incomplete union of this fracture was found The proximal fragment was so badly displaced that the deformity could be overcome only by complete removal of this fragment The removal of this left the joint surface of the scaphoid bone exposed with a gap of approximately 1 1/2 inches between it and the distal fragment of the first metatarsal A periosteal transplant was removed from the right tibia with a small piece of fascia attached to its outer margin This fascia was sutured to the soft tissue so that it formed a septum or curtain over the joint surface of the scaphoid The periosteum was rolled into a tube and sutured to the periosteum of the distal fragment and to the soft tissues in the sole of the foot thus forming a pure periosteal transplant across the defect in this metatarsal Figures 7 and 28 show the rapid development of new bone which filled in the defect and resulted in a complete cure in this case

CASE 9 G W female 35 years of age operated upon at Gary Indiana with Dr Ira Miltimore on July 15 1927 had suffered fracture of both bones of the forearm middle third some 8 months previously Several attempts at reduction were made and fair alignment of the fragments was finally attained The fragments were immobilized with mechanical rather than plaster splint and immobilization was very imperfect At the end of 6 months the case was referred to Dr Miltimore He attempted by closed reduction and immobilization to secure union and by the end of 2 months it was evident that permanent non union existed At operation the sites of fractures were exposed by two incisions the ends of the fragments freed and attempt to wedge them together by notching made No internal splint was used The absence of all periosteum about fractured fragments was definitely noted A large strip of pure periosteum was then removed by blunt dissection from the right tibia and this was divided equally into two parts one portion of periosteum was wrapped approximately one half way around the shaft of the radius and the other portion about the shaft of the ulna at the site of the fractures The wounds were then packed and a plaster splint with circular band of plaster of Paris bandages applied for external splinting as described below Sterile gloves and gowns were then again put on by the operator and his assistant the splint in the neighborhood of the

wounds carefully covered by sterile towels and the packing then removed from the wounds for inspection Slight adjustment was necessary to secure fair anatomical alignment of the fragments soft tissues and skin was then closed This patient now has union of both fractures (November 1 1927) Figures 29 30 and 31 show the growth of the periosteal transplants

#### INTERNAL VERSUS EXTERNAL SPLINTING

Before granting the value or superiority of such a transplant as this thin soft periosteal tissue the question of fixation and alignment of the fractured fragments must be met If we will acknowledge that the periosteum on a complete bone graft is the chief osteogenic layer of the graft then the chief function of the cortex or firm bone of the transplant is to act as an internal splint to bridge across the defect holding the two ends fixed and in alignment In the majority of cases this cortex splint must be held in close approximation and fixation to its host by some foreign material such as chromic catgut or kangaroo gut autogenous or ivory peg wire etc Groves seems to favor a peg or wire as firm fixation is of prime importance and he states that when a peg is used dead bone is of equal value to an autogenous bone peg

Since foreign material must be included so frequently with the autogenous bone graft then why should we not resort to some form of foreign material as a means of internal splinting and fixation of the bone fragments combined with the easier obtained and far superior large periosteal grafts In many cases the fragments can be held in approximation and fixation by the use of external plaster of Paris splint with plaster of Paris encircling cast above and below the defect or the fragments can be impacted after freshening or even held by kangaroo gut and then the defect wrapped with the periosteal graft But when this is impossible or there is a considerable loss of bone substance to be bridged then either a cortical graft must be used or a foreign material substitute employed

Following the above reasoning I began the use of beef bone pegs as a means of internal splinting when necessary some 4 years ago Recognizing that the round beef bone peg filling the entire medullary

canal frequently resulted in absorption of the cortex adjacent to the peg. I had made a triangular beef bone peg which came into contact with the medullary canal at only 3 points. This peg has absorbed more rapidly than the round peg and has caused less bone absorption. A number of methods have been devised for pushing or pulling the round beef bone peg from the intramedullary canal of one of the fragments downward or upward into the medullary canal of the adjacent fragment. The method usually used is that of chiseling a small window in the shaft of the upper fragment inserting a pair of artery forceps and grasping a suture threaded through the end of the beef bone peg already inserted in the opposite medullary canal. Traction upon this suture then pulls the peg upward or downward into the adjacent canal. This technique adds considerably to the length of the operation. To overcome this objection I had the triangular beef bone peg notched. A small spatula could then be slipped between the approximated fragments grasping the notch each in turn and shoving the peg upward or downward into the adjacent canal. This overcomes most of the difficulties of inserting a beef bone peg.

Years ago I gave up the use of Lane plates of wire and of other metallic material as a means of internal fixation due to three facts: first the presence of these metallic substances frequently resulted in bone absorption; second it was frequently necessary to remove them; third in the majority of cases some better method of fixation could be secured. The same objections can be applied to the use of the circular beef bone peg and also to the triangular peg. I have been forced to remove two beef bone pegs and another surgeon has removed one of the pegs that I have inserted and careful observation of the X-ray reproductions in this article show that in a few cases bone absorption has occurred. Therefore I am less and less prone to use any method of internal fixation except the osteal periosteal graft when there is considerable bone defect. In all other cases I have found external splinting sufficient.

In all cases of open reduction of fractures or of operation on old ununited fractures I

am now using the following plan of external splinting. After the operation is completed on the bone proper and before the soft tissues are closed over the repaired fracture the wound is carefully packed and protected from contamination. While this is being done an assistant is molding a plaster of Paris splint of the desired length for the extremity. One layer of thin sheet wadding or often no padding at all is used. The splint is then applied directly to the limb opposite the operative wound. The splint is fixed to the extremity by a few turns of a circular plaster of Paris bandage applied in the case of a leg first about the thigh then just below the knee above the site of the operative wound. Another circular plaster of Paris bandage is thrown around the splint and lower extremity just below the operative wound. Only one or two turns of this plaster bandage is applied below at this time. During the application of this splint and circular bandage an assistant has held the extremity in proper position to maintain the apposition and alignment of the fragments. The operator and one assistant now put on fresh sterile gowns and sterile gloves, clean linen is put under and over the extremity and sterile towels are packed carefully into the margins of the splint so that the packing in the operative wound can now be removed leaving the operative field sterile. The repaired site of fracture is carefully inspected and any slight readjustment of the fragments that is necessary is made. This can all be done before the splint has become too hard for slight readjustments. By actual inspection the operator now knows that he has his fragments properly aligned and while the assistant holds the extremity until the splint becomes hard the soft tissues and skin can be closed by the operator. The splint can now be strengthened by further plaster of Paris bandages.

The patient can be returned to his bed and X-ray pictures taken the next day and in every case thus far the fragments have been in exactly the position arranged at the operation. This inspection method is so simple that one wonders why we have always closed our wounds in the past and then

applied our circular casts or splints constantly dreading that the fragments would slip and often finding when the X ray picture is taken that they have slipped necessitating further operation or manipulation

### CONCLUSIONS

1 The consensus of opinion of practically all investigators on the subject of How Does Bone Grow? indicates that periosteum of all the three bone layers contains the chief osteogenesis

2 Pure periosteal transplants containing no cortical substance whatsoever in the cases herein reported have resulted in union of fractures in delayed union in repair of ununited fractures and in bridging across large bony defects. Studies of the serial X ray pictures in each case show the new bone formation starts and continues from the transplanted periosteum

3 Experience in this method has taught that best results are obtained the more completely the shaft at the site of the fracture is covered by the periosteal transplant. In the neighborhood of these old fractures especially with non union the adjacent fragments are practically always completely denuded of periosteum. Therefore the aim of this transplant is to replace as nearly as possible this osteogenic layer

4 External splinting as a method of hold-

ing the fragments in alignment is far superior to any method of internal splinting or fixation by means of foreign material such as Lane plates wire beef bone pegs etc

5 When there is considerable bony defect which must be bridged the autogenous graft or better the osteal periosteal transplant is probably superior to the pure periosteal transplant

6 Whichever method bone graft osteal periosteal or pure periosteal transplant is used more rapid and better results will be obtained if a large piece of periosteum is employed to surround most of the shift at the site of the defect

7 In practically every case in which an autogenous bone graft is indicated the same repair can be obtained more rapidly and with less trauma to the tissues by the use of an osteal periosteal or pure periosteal transplant

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# EXPERIMENTAL STUDY OF THE FACTOR OF BILIARY STASIS IN THE PRODUCTION OF GALL STONES<sup>1</sup>

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**S**TASIS of bile in the biliary tract has long been considered a predisposing and exciting cause of gall stone. Attention has recently been called anew to this factor by the experimental work of Whitaker, who has produced gall stone in cats by the stagnation of bile alone. To induce stasis of bile in the gall bladder, he cut and dilated the sphincter of the common bile duct of the cat, a procedure which has been shown to prevent refilling of the gall bladder. Nine hours afterward the cat was given a fat meal to cause partial emptying of the gall bladder, and was then starved for several days when autopsy showed a stone apparently a cast of the shrunken gall bladder.

Production of stone in the gall bladder by stasis alone seemed so striking that we have repeated and extended the experiment of Whitaker. His technique for the production of stasis by cutting the sphincter was carried out on 18 cats. In many of the experiments described by Whitaker, iodized oil was introduced into the gall bladder to demonstrate the stasis of bile. To eliminate this factor, which we thought might play some part in the process described by Whitaker, the iodized oil was injected into the gall bladder of only 7 of the 18 cats. In the gall bladder of the 11 cat in which stasis had been produced but no iodized oil injected, there was not the slightest trace of the formation of stone. Six dogs, similarly treated, likewise did not show stones. Of the 7 cats in which iodized oil was injected into the gall bladder, 3 had semi-solid masses resembling the stones described by Whitaker. As iodized oil seemed to be the deciding factor in the production of these masses, another series of experiments was performed in which no stasis was produced. Iodized oil was merely injected into the nor-

mal gall bladder. Similar masses were sometimes found in the empty gall bladders although no stasis was present. These experiments seem to indicate clearly that the iodized oil rather than stasis was the important factor in the production of these so-called gall stones.

The semi-solid masses which were produced in the gall bladders containing lipiodol seemed to be similar to those described by Whitaker. These masses have little resemblance to human gall stone. They are greenish black, soft and homogeneous, varying in size, sometimes occupying the entire gall bladder. Examination shows the presence of fat globules in the specimens. We were inclined to think at first that soaps were present, but chemical examination did not confirm this. Cholesterol was not found, which again strongly suggests that they bear little relation to human gall stone, but instead result directly from the presence of iodized oil.

Believing, nevertheless, in spite of our negative experiments, that stasis is undoubtedly one factor in the production of gall stone in man, we performed experiments in which stasis of the bile was associated with another important factor, infection. Stasis of bile was produced in cats after the method of Whitaker by cutting the sphincter of the common bile duct. Stasis was produced in dogs by another method which insured complete stagnation in the gall bladder and yet did not cause obstructive jaundice. This is made possible by the anatomical arrangement of the ducts in the dog. Two lateral hepatic ducts join the common bile duct at a considerably lower level than the junction of the middle hepatic and cystic ducts. The common bile duct can therefore be ligated in its upper part so that the middle hepatic duct drains only into the gall bladder from which emptying is prevented by the ligature. This technique insured complete stasis in the gall blad-

Whitaker, L. R. Th. m. h. m. f. b. g. l. l. b. l. d. d. i.  
11th J. Am. f. A. l. s.

F. m. th. D. p. tm. f. s. g. y. W. h. gt. U. ty. M. d. S. hool. d. B. Hosp. t. l.

der and at the same time maximum concentration of bile

Simultaneously with the production of stasis by these methods in cats and dogs organisms were introduced into the gall bladder bacillus coli staphylococci and streptococci being used. The animals were sacrificed after periods varying from a few days to several weeks. Neither cholelithiasis nor chronic cholecystitis was thereby produced in any instance.

Experiments were then performed in which substances which might serve as nuclei for stone formation were placed within the gall bladder where stasis of bile had been induced. In some instances infection of the bile was added. Tissues of parenchymatous organs, fragments of metal gauze, calcium lactate, cholesterol, lecithin and colloidal substances were used. No stones were formed under any of these conditions. In one cat, however, in which a piece of gauze infected with bacillus coli was inserted into the gall bladder a marked degree of chronic cholecystitis resulted.

In another group of cats the sphincter of the common bile duct was cut and the walls of the gall bladders in some instances the mucosa and in others the serosa were thoroughly cauterized with phenol. Autopsy of the ani-

mals after varying lengths of time did not reveal any stones.

As another point against the importance of stasis as the sole factor in the production of stones is the fact that those individuals whose bodily constitutions are associated with the greatest amount of stasis in the gall bladder, namely the viscerototics, are not so likely to have stones as the short obese type. This point is elaborated in a paper by Sherwood Moore now in press.

#### SUMMARY

Clinical opinion has suggested the importance of stasis of bile, infection and the presence of nuclei in the gall bladder as factors in the production of gall stones in the human. We have not been able, however, to induce cholelithiasis in experimental animals by either stasis alone or by stasis combined with infection of the bile, even in the presence of various foreign bodies. Obviously other conditions seem necessary for gall stone formation. A likely factor may be intramural infection, especially since clinical investigation by one of us<sup>1</sup> has shown its frequent presence in cholelithiasis even when the bile is sterile.

Illingworth C. F. W. Type of gallbladder stones 97

## FACTORS INFLUENCING PROGNOSIS IN CARCINOMA OF THE RECTUM<sup>1</sup>

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I. m. h. D. I. g. y. J. h. sec. S. I. P. th. l. y. M. y. Cl. ic

**I**NFLUENCES which favor or prejudice the successful outcome of the surgical treatment of rectal or rectosigmoidal carcinomata readily divide themselves into two groups—extrinsic and intrinsic. The extrinsic are modifying influence such as age, general condition of the patient, duration of the lesion with its attendant signs and symptoms, and various local conditions associated with the neoplasm such as its size, situation and mobility, the presence or absence of metastasis, both lymphatic and visceral, fibrosis, lymphocytic infiltration, and hyalinization. The intrinsic influence with its attendant effect on extrinsic influence is represented by the activity of the cancer cell themselves. From the surgical standpoint extrinsic factor except such elements as age and such general evidences of resistance as the extent of local resistance expressed in terms of fibrosis and so forth determine the so called operability of each case. This controversial appellation implies conditions favorable and unfavorable to the removal of cancerous growths, condition which in borderline cases must be measured and evaluated by the judgment, experience and courage of the surgeon.

Nowhere is there any dissension from the dictum that metastasis to the liver rules out radical resection except in the small group of cases in which removal of the growth with restoration of the lumen of the bowel seem advantageous as a palliative measure.

Fortunately, one may resect portions of the prostate gland or seminal vesicle or perform hysterectomy in the course of an operation for extirpation of rectal carcinoma with relatively satisfactory mortality in certain selected cases. Whether or not the high mortality and morbidity and end results in this particular group of cases warrant radical operation is extremely questionable and one wonders (considering the fact that many patients suffering from inoperable carcinoma of the rectum who have been subjected to palliative

colostomy enjoy a relatively satisfactory existence for 1 or 2 years) whether extensive technical feats which unquestionably produce prolonged disability are compatible with sound judgment. Occasionally one of these extremely radical operations is followed by prolonged freedom from recurrence and encourage the practice of attempting to remove large fixed carcinomata, but if the sacrifice of important organs is necessary in the course of the operation more often than not such feat result in high immediate mortality and early recurrence. In the light of comparative result with other therapeutic agents however the suppression of carcinoma calls for extension in the scope of operability.

Undoubtedly the best prognosis in the surgical treatment of rectal carcinoma attends that very favorable group of cases in which operation may be performed early and in which the growth is not fixed, has not involved the lymphatics and is found on resection not to have invaded the musculature of the colon. In this group of cases the operative mortality is extremely low for any type of resection and the percentage of cure is very high. We have not grouped our cases as favorable and unfavorable but taking the cases which have been subjected to resection as a routine we find that in approximately half of them there has been no recurrence at the end of 3 years and in a third the patient is alive and free from recurrence at the end of 5 years. The operative mortality in the whole group for the double operation of colostomy and posterior resection was approximately 6 per cent.

Our rule in cases in which metastasis to the liver has not occurred is to attempt the resection of the offending growth in every case if it is not wholly immobile from fixation to adjacent organs.

Fortunately metastasis is a slow process and even lymphatic involvement does not take place rapidly. The first recurrence after operation is usually noted in the liver. Death

TABLE I—GRADE OF MALIGNANCY AND METASTASIS AT OPERATION

	G d	G d	G l s	G d 4	All g des
P t t w th m ta, tasis	( 6 8 <sup>cc</sup> f 8 )	3 (44 3 <sup>cc</sup> f 90)	77 (56 <sup>cc</sup> f 37)	13 (64 7 <sup>cc</sup> f 5 )	260 (46 4 <sup>cc</sup> f 56 )
P t t s w th t m tasis	60 (73 7 <sup>cc</sup> f 8 )	6 (55 8 <sup>cc</sup> f 90)	6 ( 3 79 <sup>cc</sup> f 37)	8 (35 9 <sup>cc</sup> f 5 )	300 (53 57 <sup>cc</sup> f 560)
Lymph odes xamined	8	90	37	5	
Lymph odes t m ed	3	9	4		
T t l	5 ( 7 55 <sup>cc</sup> f 59 )	99 (5 00 <sup>cc</sup> f 593)	4 ( 3 57 <sup>cc</sup> f 598)	53 (8 80 <sup>cc</sup> f 598)	
On tag typ f pe t as Qu T tl Har us C pp					

from metastasis to the liver is painless in the majority of instances in marked contrast to the long drawn out suffering which accompanies ulcerating adherent and inoperable growths. Sepsis from these huge foul surfaces rather than metastasis is the cause of death. Local fixation unquestionably is the cause of refusal of radical operation more frequently than internal metastasis.

The inadvisability of excluding the possibility of metastasis is evidenced by the fact that many times one feels that the hard lymph nodes in the immediate vicinity of the growth are an evidence of extension of the carcinoma. However this may frequently be proved erroneous by microscopic examination and it is unwise to assume from palpation that all lymph nodes are cancerous; many nodes will be found on more careful examination to be inflammatory and the possibility of radical operation will not be excluded.

The duration of the growth and its situation influence the surgical outlook enormously. It is a difficult problem to fix the exact duration of symptoms and signs in a case of rectal carcinoma since at the time the patient appears for treatment symptoms and signs have been present for many months and not infrequently for years. In the average case of rectal carcinoma observed at the Mayo Clinic symptoms have been present for more than a year. Since the signs and symptoms always consist of blood in the stools, change in bowel habits or some obstructive phenomena the growth must have progressed to the point of ulceration or occasionally to subacute obstruction before the patient is aware of its presence. The type of growth influences the duration of symptoms and signs depending on whether it is a rapidly progressing

cellular carcinoma or a more slowly growing type.

The situation of the growth is of importance from the standpoint of prognosis because the pathological types vary in different parts of the rectum and because of the influence on the time at which symptoms and signs appear. Most growths in the rectum occur in its ampullary portion or higher at the rectosigmoidal juncture. The smallest percentage of growths are in the anal canal and around the external anal orifice. The latter growths are usually epitheliomata and can always be recognized by the most superficial general examination. It seems entirely reasonable that they should be observed in their earliest stages. On the contrary, however, many cases of several years duration are on record. The lymphatic drainage in this area is forward into the groin rather than retroperitoneal and lateral as it would be were the growth higher, but in any event once the lymph nodes in the groin are involved radical operation is useless and the prognosis is hopeless.

Rectosigmoidal growths are not readily felt by the examining finger but occasionally they telescope themselves into the ampulla of the rectum and may be palpated easily. The difficulty of determining the exact situation of the growths by proctoscopic examination is demonstrated in this class of cases in which operation sometimes reveals the growths at or above the rectosigmoidal juncture although they have been observed physically well down in the middle of the rectum. In women growths in this situation are usually palpable through the vagina particularly if fixation has occurred since the tendency of a growth in the lower part of the sigmoid is to drop down into the cul de sac and fasten itself onto the



TABLE II—GRADE OF MALIGNANCY AND RESULTS OF OPERATION

	Grade I	Grade II	Grade III	Grade IV	All grades
1st m	or 1st	( 7 )	( 1 )	( 4 )	
L	( 6 )	( 8 )	( 1 )	( 5 )	
P	( 3 )	( 5 )	( 1 )	( 1 )	
I d	( 8 )	( 6 )	( 1 )	( 5 )	
Poo	( 3 )	( 8 )	( 1 )	( 1 )	
T	( 8 )	( 6 )	( 1 )	( 1 )	
T 1st	( 8 )	( 3 )	( 1 )	( 1 )	
Th	( 1 )	( 1 )	( 1 )	( 1 )	
f	( 1 )	( 1 )	( 1 )	( 1 )	
h	( 1 )	( 1 )	( 1 )	( 1 )	
Th	( 1 )	( 1 )	( 1 )	( 1 )	
b	( 1 )	( 1 )	( 1 )	( 1 )	
f	( 1 )	( 1 )	( 1 )	( 1 )	
Th	( 1 )	( 1 )	( 1 )	( 1 )	
d	( 1 )	( 1 )	( 1 )	( 1 )	

posterior wall of the uterus. Rectosigmoidal growths require an abdominal type of operation which is a more formidable procedure than posterior resection following colotomy and yet because of their early obstructive signs they should be recognized in an earlier stage than the lower growth of the rectum proper. By using a graded operation which consists of colostomy and an interior type of resection one of us (Rankin) has removed the rectosigmoid and rectum down to the anal canal in a series of 23 consecutive cases with but 1 death. This reduction in mortality has been due to several factors—the most essential of which are adequate preoperative preparation and the use of spinal anesthesia. The operation permits wide removal of the lymphatic structure and the remote results should be satisfactory. If the growth is situated in the middle or upper portion of the

rectum extirpation by either the graded operation of colotomy and posterior resection or the abdominoperineal type of procedure as advocated by Jones or Mile may be carried out with low mortality and satisfactory end results.

Age is another factor which influences prognosis is most emphatically. Fortunately the average age in cases of carcinoma of the rectum is more than 50 years. Most of the patients at the Mayo Clinic have been between the age of 45 and 60 and most satisfactory end results have been obtained by radical operation on the elderly patients. There is ample clinical evidence to the effect that the prognosis in rectal carcinoma in the earlier decade is highly unfavorable. Unfortunately, there are a great many cases of carcinoma of the rectum in patients between the ages of 20 and 30 and even below 10. The active tissue

TABLE III—METASTASIS (GRADE OF MALIGNANCY AND RESULTS)

	Grade I	Grade II	Grade III	Grade IV	All grades
P	( 1 )	( 6 )	( 1 )	( 1 )	
I ( m	( 1 )	( 1 )	( 1 )	( 1 )	
L	( 1 )	( 1 )	( 1 )	( 1 )	
P	( 1 )	( 1 )	( 1 )	( 1 )	
I d	( 1 )	( 1 )	( 1 )	( 1 )	
Poo	( 1 )	( 1 )	( 1 )	( 1 )	
T	( 1 )	( 1 )	( 1 )	( 1 )	
T 1st	( 1 )	( 1 )	( 1 )	( 1 )	
Th	( 1 )	( 1 )	( 1 )	( 1 )	
f	( 1 )	( 1 )	( 1 )	( 1 )	
h	( 1 )	( 1 )	( 1 )	( 1 )	
Th	( 1 )	( 1 )	( 1 )	( 1 )	
b	( 1 )	( 1 )	( 1 )	( 1 )	
f	( 1 )	( 1 )	( 1 )	( 1 )	
Th	( 1 )	( 1 )	( 1 )	( 1 )	
d	( 1 )	( 1 )	( 1 )	( 1 )	



FIG. 1. Adenoma in which the cells are practically completely differentiated for this reason it is called benign.

of youth instead of resisting cancer invasion invite its spread and the young person who is host to a malignant neoplasm has little chance for longevity regardless of the type of therapeutic measures instituted. The lymphatic senescence and tissue inactivity common to advancing years offer a much more satisfactory first line of defense than the vital elasticity of youth.

# PATHOLOGY

Carcinoma of the rectum like carcinoma of other parts of the gastrointestinal tract is usually of the adenomatous or gland type occasionally a squamous cell epithelioma or epidermoid carcinoma is found but it is usually situated at the anus. When a squamous cell epithelioma is found above the anus its origin



FIG. 2. Adenocarcinoma graded 1 in an adenoma. The cells in the acini in the upper left hand corner are practically completely differentiated while those in the acini in the right and lower part of the section are not; the latter are therefore cancerous.

is explained in the same way as that of epithelioma of the stomach and gall bladder the regenerative cells of the glandular epithelium in these organs have the power to produce either a secretory (glandular) epithelium or a protective (squamous) epithelium. In this series of cases there was also one melanoma epithelioma situated just inside the anus; this is rare in the rectum. Adenocarcinoma of the rectum like carcinoma of other parts of the intestinal tract presents different gross forms: papillary, polypoid, mucoid, ulcerating, infiltrating, napkin ring, and so forth. It is also liable to infection and degenerative processes as well as to ulceration. Microscopically the cells of adenocarcinoma of the rectum may be

TABLE IV.—ABSENCE OF METASTASIS, GRADE OF MALIGNANCY, AND RESULTS

	Grade	Grade	Grade 3	Grade 4	All grade
Pathologically	60 (100% f 3)	6 (54.00% f 300)	6 (100% f 300)	8 (60.00% f 300)	
Infected	58 (96.66% f 60)	58 (97.53% f 6)	58 (96.66% f 6)	7 (94.44% f 8)	
Lymphatic Good es l Poor l	3 (55.56% f 58) 3 (93.75% f 3) (6.55% f 3)	7 (68.33% f 58) 7 (97.0% f 74) (7.0% f 74)	4 (43.75% f 53) 3 (9.8% f 4) (4.67% f 4)	6 (35.90% f 7) 6 (100% f 6)	
Distant Good es l Poor es l	6 (44.8% f 58) (3.33% f 5) 3 (86.66% f 5)	8 (53.6% f 58) (7.64% f 68) 56 (83.35% f 68)	34 (59.64% f 57) 4 (100% f 4)	16 (7.7% f 7) (8.8% f ) 9 (8.8% f )	
Total good es l	3 (68.08% f 47)	84 (59.5% f 4)	3 (79% f 5)	8 (47% f 7)	7 (57.87% f 54)
Total poor es l	5 (59% f 47)	58 (4.84% f 4)	5 (5.08% f 48)	9 (59.44% f 7)	7 (100% f 5)



Γ 3 \1 m k d d l t h f t  
d b l m l f t h l f l h h t l f t h y p t  
m l k t d t h l f t h l f l



l 4 \d m k j d t l cell n the c  
t t l l f t t l t h t p l l  
t t f t h t w l f m l

differentiated to such a marked degree and arranged in glandular or acinous formation with such good cell alignment that they appear almost like normal rectal mucous glands. A number of these cells even secrete mucus that is indistinguishable from the mucus secreted by a benign adenoma. As a matter of fact a number of carcinomata of the rectum of low grade malignancy originate in adenomata. Furthermore, contrary to the prevailing opinion, Saint has shown that the change from a

benign adenoma to a carcinoma takes place more often at the periphery than at the base. Mitotic figures may or may not be numerous in the carcinoma showing advanced differentiation but they are usually regular in form. On the other hand carcinomata of the rectum may be so undifferentiated that practically all trace of gland formation are lost. The cell nuclei are usually large irregularly roundish and deeply staining and as a whole the cells have lost their columnar form.

TABLE A.—NO LYMPH NODLS REMOVED. GRADE OF MALIGNANCY AND RESULTS

	C 3	C 1	G 1	C 1
N 1 m h l m l	3 (6 f 8)	( 8 <sup>ov</sup> f 5)	( 5 <sup>ov</sup> f 38)	(5 6 <sup>ov</sup> f 35)
I f m	3 ( 00 <sup>ov</sup> f )	3 3 83 <sup>ov</sup> f )	( 00 <sup>ov</sup> f )	( 0 <sup>ov</sup> f )
L Goo l l Poo l	8 6 <sup>ov</sup> f ) 8 ( 5 6 <sup>ov</sup> f 0)	( 5 00 <sup>ov</sup> f 8) ( 00 f )	( 5 00 <sup>ov</sup> f ) ( 00 <sup>ov</sup> f )	
D 4 G l l Poo l	( 7 0 <sup>ov</sup> f 3) ( 6 6 <sup>ov</sup> f )	6 (75 00 f 8) 6 ( 00 f 6)	(75 00 <sup>ov</sup> f 4) ( 00 <sup>ov</sup> f )	( 0 <sup>ov</sup> f ) ( 0 <sup>ov</sup> f )
T l o s l	(86 3 <sup>ov</sup> f )		( 00 <sup>ov</sup> f )	
T l no l	( 6 0 <sup>ov</sup> f )	8 ( 00 <sup>ov</sup> f 8)	( 3 00 <sup>ov</sup> f )	( 00 <sup>ov</sup> f )

A p e f m e d h h Q T t l H s o C j



FIG. 5 Adenocarcinoma graded 3 showing less cell differentiation than Figure 4 with irregular acinar formation.



FIG. 6 Adenocarcinoma graded 4 with mucoid formation. Note the undifferentiated state of the cells for the most part and the ill defined acini.

Mitotic figures may or may not be numerous but are often irregular (multiple mitosis). When acini or gland formations are found in such carcinomata the cells are not in good alignment and show very little tendency to individual cell differentiation.

In our series of carcinomata we have found a number that show mucoid or colloid secretion. This material may be associated with cells in all degrees of differentiation; however, on the whole, if it is found in large masses the cells associated with it are usually of a columnar type. One often sees acini so distended with this material that a number or all of the cancer cells in them have been destroyed by pressure. When the material is associated with undifferentiated cells it is usually less in amount and is often retained in the cell giving it a signet ring appearance.

#### GRADES OF MALIGNANCY

The malignancy of carcinoma of the rectum like that of carcinomata in other situations is subject to gradation on the fundamental principle of cell differentiation. In 1915 one of us (Broders) began grading malignant neoplasms on the fundamental principle of cell differentiation and during the following 4 years 1,628 squamous cell epitheliomata were graded strictly from a microscopic viewpoint and absolutely independently of the clinical

histories. In 1915 it was thought best to modify the original basis to some extent. The mitotic figures and the one-eyed cells were considered only as undifferentiated cells and it was only in the presence of numerous irregular mitotic figures that there was an inclination to raise the grade.

Recently we have studied 598 cases of carcinoma of the rectum operated on between 1916 and 1925 and graded the malignancy in accordance with Broders' method. From Table I it can be plainly seen that the percentage of cases in which metastasis is present rises in direct proportion to the grade of malignancy and that absence of metastasis increases in inverse proportion to it.

Table II shows the grade of malignancy and its relation to the ultimate result. The percentage of total good results decreases in inverse proportion to the grade of malignancy and the percentage of total bad results increases in direct proportion to it.

Table III shows the relationship of metastasis, grade of malignancy, and ultimate results. It is evident from the total percentage that the good results decrease in inverse proportion to the grade of malignancy and the bad results increase in direct proportion to it.

Table IV shows the relationship of absence of metastasis, grade of malignancy, and ultimate results. The percentage of total good



F 7 M l p th l m f g l d 4 \ t th  
c m l m gl l t th l t D ff t t th  
c ll f th m p t ll l t M l  
f d l p ts

results decrease in inverse proportion to the grade of malignancy and the percentage of total bad results increases in direct proportion to it. While the grade of malignancy has its influence on the good and bad results in the absence of metastasis this influence is not as marked as when metastasis is present. It can also be noted that in cases of carcinoma graded 3 or 4 without demonstrable metastasis the result is not much better than when metastasis accompanies a carcinoma graded 1.

In Table V the grade of malignancy and the results are compared in a series of cases in

which the nature of the operation precluded the removal of lymph nodes.

Table VI shows the relationship of grade of malignancy ultimate result and duration of life since operation. It can be seen that the grade of malignancy plays practically no part in the average duration of life of those who are living and it plays practically no part in the duration of life of those who died after a good result but it plays a part in the average duration of life in those who died from the carcinoma since the average duration decreases as the grade of malignancy increases (Fig. 1 to 7).

CONCLUSIONS

1. Extrinsic influences are in the main modifying in type age being one which empirically prejudice successful prognosis.

Duration of the growth is important but its exact determination is difficult change in bowel habit and obstructive phenomena being the most dependable sign which call attention to the presence of a growth.

2. Fixation influences operability and in consequence operative mortality and successful outcome. Fixation in many instances is the result of inflammatory change rather than direct extension of malignancy and in consequence radical maneuvers in selected cases give unexpectedly successful result although this is the exception rather than the rule. Occasionally drainage operations permit a recession of inflammatory processes and sub

TABLE VI—GRADE OF MALIGNANCY, ULTIMATE RESULT AND DURATION OF LIFE

	G d	l	G d	G d
T l	5			5
I f m				
L	8			8
Good	55	oo		33
Le		3	y	oo
h	5 oo			y
A	53	6		5 y
Pro		3	y	
Le				
h				
A			y	
g				
D d	5	5		
Good	8			6 53
Le				oo
h	8	( m	8 8 m	5 m
A		l)	d)	3
Poo		7 66	oo	7 75 y
L	7 75	3	oo	
h			7	53
A	3 rs			

sequent resection after immobility has been considered sufficient to rule out resection at the primary exploration

4 Site of the growth influences outcome because of pathological type and early detection epitheliomata of the anal canal being early recognizable and satisfactorily removed by local operation while the type of neoplasm found higher in the rectum is practically always adenocarcinomatous

5 The grade of malignancy has a direct bearing on the percentage of metastasis and absence of metastasis since the percentage of cases showing metastasis increases in proportion to the grade and the percentage of cases without metastasis increases in inverse proportion to it

6 The influence of the grade of malignancy on the ultimate result is indicated by the fact that the total of good results decreases in inverse proportion to the grade while the total of poor results increases in proportion to it

7 From a comparison of the influence of metastasis and that of the grade of malignancy it is obvious that the grade of malignancy is the dominant factor since the total of good results decreases in inverse proportion to the grade and the total of poor results increases in proportion to the grade

8 When the influence of the absence of metastasis and of the grade of malignancy on the ultimate result are considered together the influence of the grade is still evident but

not to such a marked degree as when it is considered with metastasis

9 If the percentage of metastasis increases as the grade rises and the influence of the grade of malignancy on the ultimate result has been established beyond doubt it is reasonable to assume that the total of the good results in the presence of metastasis will not be as high as and poor results higher than when metastasis is absent furthermore the total of good results when metastasis is absent should be higher and the total of poor results lower than when metastasis is present Actually the total of the good results when metastasis was present was 20.68 per cent and the total poor results was 79.31 per cent When metastasis was absent the total good result was 57.87 per cent and the total of the poor result was 42.1 per cent

10 It will also be noted that almost as good a result is obtained in the case of carcinoma of the rectum graded 1 with metastasis as in the case of carcinoma graded 3 and 4 without metastasis Furthermore there has not been a good result in this series when malignancy was graded 4 and metastasis was present

11 The influence of the grade of malignancy on the duration of life after operation in cases in which death occurred from the carcinoma is shown by the fact that the average duration decreased as the grade increased

## HYDATID DISEASE OF THE KIDNEY

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H. D. m. C. U. I. R. H. M. H. I. I.

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**H**YDATID disease is distributed throughout the world in those countries that have become famous for wool growing, Australia, New Zealand, Argentina, Iceland, Southern Europe, and Northern Africa.

In Australia the name *taenia echinococcus* has become restricted to that for the parasite itself. When it attacks human beings it assumes the bladder worm stage and the condition produced is always known as hydatid disease.

Sheep, dogs, and men are the three factors concerned in the development of the disease. It takes on an average of 15 to 20 years from the time of infestation before the patient seeks surgical relief, so slowly and inordinately does hydatid disease progress. If the encouragement of wool growing in the United States of America and Canada continue, we feel sure that the next generation of surgeons in these two great countries will have more opportunities of studying the manifestations of hydatid disease than their predecessors had.

Public health measures in Iceland and Australia have brought about a definite reduction in the disease as manifested in man. Sheep farmers know the danger of feeding their dogs on the uncooked livers of infested sheep. This one step arrests the disease at its source.

Of 1,460 cases of hydatid disease admitted into the Royal Prince Alfred Hospital during the past 4 years, 28 or 1.9 per cent. the disease affected the kidney. It is not a common disease. During the past 15 years, 16 cases of renal hydatid have come under our observation. A summary of the histories is appended. Of these 11 were males, 5 were females, 8 were in the right kidney and 8 in left. The average age when the patients were seen was 40 years. The youngest patient was 9 years old, the oldest 67.

The hydatid embryo may reach the kidney at the primary infestation of the host even if the infestation consists of only a single embryo. If the infestation consists of many embryos, then the kidney will share its fortune with other organs.

A secondary infestation of the kidney may occur from the rupture of a hydatid cyst into some part of the blood stream. If the patient survives this disaster, the kidney alone with other organs may be the seat of many hydatid cysts. Clinically there may be so many tumors present that the diagnosis of secondary malignant disease is made. This type of multiple infestation of the kidney is usually discovered postmortem and has never in our surgical service come within the scope of operative surgery.

In this series of cases we include only those hydatids that arise within the kidney substance. Some authors (10) include infestation by implantation on the juxta renal peritoneum. In the surgical service of the Royal Prince Alfred Hospital, Sydney, we have not seen a hydatid cyst which has invaded the kidney in this way. Many have been found in contact with the kidney, but never truly invading it. Expansion of a hydatid occurs along the line of least resistance, which is under the circumstances toward the peritoneal cavity and away from the kidney.

If a hydatid were anchored by firm peritoneal adhesions close to the kidney, it would be theoretically possible for it to invade the kidney. We have yet to see this happen.

Hydatids within the peritoneal cavity should be classified as abdominal or peritoneal. They arise from traumatic or spontaneous rupture of a hydatid of the liver or spleen into the peritoneal cavity. The kidney, peritoneal pouches, as well as other pouches, are involved in a general infestation of the peritoneal cavity. This type of infestation also follows the



Fig. 1. Hydatid of the lower pole of the left kidney. Anterior aspect.

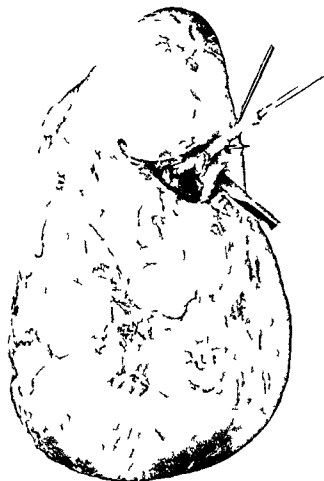


Fig. 2. Same kidney as that shown in Figure 1 from medial aspect.

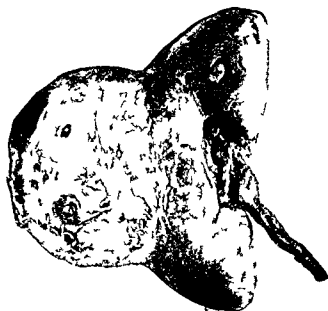


Fig. 3. Cystic enlargement of right kidney closely resembling hydatid of the kidney.

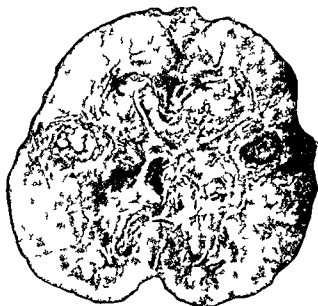


Fig. 4. Small hydatid of the left kidney containing two daughter cysts.



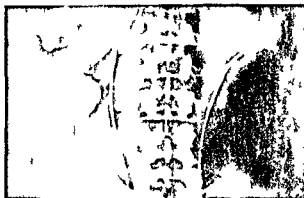


FIG. 1. (Left) Hydatid cyst of the kidney, with the cyst wall removed.



FIG. 2. (Left) Hydatid cyst of the kidney, with the cyst wall removed.

practice of tapping a hydatid cyst of the liver by means of an exploratory syringe. Some of the contents leak out of the needle puncture into the peritoneal cavity. The manifestation of secondary infection brought about in this way may be postponed for many years. We have seen it happen 10 years after the original tapping or rupture.

It was for this reason that tapping exploratory or as a means of treatment has been abandoned.

We cannot classify Allaben's case quoted by Kretschmer (1) as one of hydatid of the kidney.

The hydatid embryo is blood borne in the same way as a bacterial infarct and like it usually comes to rest in the outer part of the cortex of the kidney. Theoretically there is no part of the secreting or collecting kidney tissue that is exempt from the risk of infection.

The course of the disease is governed by the site at which the embryo comes to rest. Those in the upper pole are more fraught with danger than are those in the lower because of the proximity of the liver and spleen. As the disease progresses attachment to and invasion of these organs may take place. We have had an example of invasion of the liver and eventually of the lung on the right side also invasion of the spleen in a left renal hydatid. Whether a hydatid of the liver or spleen immediately above the kidney can gain attachment to that organ and then in

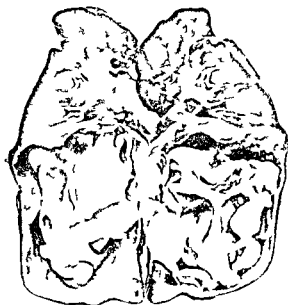


FIG. 3. Hydatid cyst of the kidney, with the cyst wall removed.



FIG. 4. Hydatid cyst of the kidney, with the cyst wall removed.

vade it is a question we cannot yet answer from our observations but we believe it possible and even probable. In advanced cases it might be difficult to determine whether the hydatid started in the liver or kidney.

In the lower pole when the spherical hydatid reaches the capsule of the kidney expansion takes place along the line of least resistance and that is toward the lower half of the abdominal cavity. In this region enormous expansion may take place without interference with important organs. Local peritonitis sometimes occurs as the growth expands and in one case acute intestinal obstruction developed from peritoneal adhesions.

In the middle region of the kidney the parasite expands until eventually the whole kidney substance is destroyed.

Contrary to the experience of others (10) we have found that displacement of the kidney does not occur in this disease. It is the hydatid that becomes displaced and not the kidney. This is borne out by a pyelogram of an upper pole hydatid published by Kretschmer (5) also by a pyelogram of a lower pole hydatid in our series published with this communication.

Hydatid may occur in a prolapsed kidney and give the impression of displacement also there may be an accompanying hydatid of the liver which is pushing the kidney from above. Evidence of this is also shown by the accompanying pyelogram.

#### INFECTION

It has been accepted up to the present time that suppuration may take place in a hydatid that has not ruptured into a secretory channel of the body of the host. From our observations we doubt this statement. We have never seen suppuration in a hydatid of the kidney that has not ruptured into the renal pelvis or a calyx. A suppurating hydatid of the liver is almost invariably bile stained or bile appears within a day or two in the drainage tube after operation. A hydatid of the lung suppurates only when it communicates with a bronchus.

The infection and suppuration has been accepted as the cause of the hydatid rupture. It is more likely in our opinion that the re-

verse of this is true that the rupture is in reality the cause of the infection.

In offering this suggestion we are influenced by the fact that there is no direct blood supply to carry bacteria to a hydatid cyst that it is fed by osmosis only through a dense vascular adventitious cyst wall together with a laminated chitinous ectocyst of considerable thickness. These structures unless actually broken by trauma would appear to be an efficient bacterial filter. Once a hydatid has broken into the upper urinary tract or into a bile duct or into a bronchus it is directly open to the attack of organisms that are known to be sometimes if not always present in these channels.

Quite apart from the question of infection the parasite when it makes its way through a mucous lined path to the outside world is only fulfilling its biological object in life—the perpetuation of its species.

It has been our experience in infected renal hydatid that the degree of infection is always mild sometimes the pus proves to be sterile on culture in all ordinary media. It is only after operation and drainage that more virulent infections manifest themselves. Postoperative infection is more common in the liver than in the kidney. This postoperative infection sometimes has killed the patient but it has had the virtue of always killing the parasite if the patient survived and the drainage tube were left in long enough. The smell of a suppurating hydatid during the first few weeks after operation is something to be remembered. You can tell at once on entering a ward if there is a case present. The opportunities of experiencing this peculiar but not altogether offensive odor are rare since the adoption of methods which avoid large drainage tubes either by the use of rubber dam or by complete closure of the wound without drainage after emptying and sterilizing the cyst cavity.

#### CLASSIFICATION

Hydatids of the kidney have been so far included under one head but there is a fundamental pathological fact which divides them into two natural groups not only from the point of view of symptomatology but from the point of treatment as well.

This fact is whether the hydatid communicates with the renal pelvis or calyx or does not do so. Those that communicate with the urinary channels we have classified as open those that do not as closed. The analogy of joint tubercle suggests the classification. Subdivision of these two types may be made as follows:

Open and closed hydatid	{	Active living
		Calcified living and dead
		Infected living and dead

#### CLOSED HYDATID SYMPTOMS

Until a hydatid has ruptured into a calyx the symptoms are those of renal tumor only. The patient may feel a movable lump in the abdomen without any pain beyond perhaps a sense of dragging or discomfort aggravated by exercise. As the cyst enlarges symptoms of diaphragmatic pleurisy may develop if the tumor is in the upper pole or lateral position; if it is in the middle region or the lower pole.

In Australia we met with an approximately spherical tumor in any part of the body; the possibility of hydatid always considered particularly if the patient has lived in a sheep district. The size of the tumor may be considerable and yet the general health of the patient remain quite up to normal standard. This combination of tumor with unaffected general health is strongly suggestive of hydatid. Hematuria is almost to occur in closed hydatids of the kidney but in 3 of 6 cases in our series it was present in 2 it was microscopic and in 1 microscopic; in 1 there was associated nephritis indicated by numerous casts; the second closed hydatid was dead and calcified; the third was the classical closed type about 4 inches in diameter.

In hydatid of the lung hæmoptoe occur in some cases for some time before rupture into a bronchus takes place. There is no reason why the same relative phenomenon may not take place in renal hydatid. The hydatid cyst may be long in contact with the mucous membrane of the pelvis or calyx before actual rupture of the cyst wall occurs. While in such contact some irritation œdema and congestion of the mucous membrane must be present. Slight trauma under these circumstances could produce hæmaturia.

#### OPEN HYDATIDS OF THE KIDNEY

When once the hydatid has burst into the urinary tract the patient is dramatically reminded at intervals that something is really wrong and he seeks surgical advice. Hæmaturia, colic and the passage of daughter cysts either whole or collapsed are the three cardinal features of the history. The patient usually describes the hydatid debris as pieces of jelly or grape skin. The colic is exactly similar to that caused by renal or ureteral stone and is variable. The hæmaturia may vary from the most profuse type down to microscopic red blood cells. It is possible for a renal hydatid to be cured by nature's method much in the same way as a hydatid of the lung. It may be voided through the natural channel. In one of our series (Case 10) this almost happened. The removed kidney on section showed only two remaining small daughter cysts. A fortnight before the patient had passed several ounces of hydatid debris and blood clot. The two small daughter cysts left behind would have been quite enough to start the hydatid all over again.

The interval between attacks varies from a few days to a few months according to the relief of tension within the cyst. If a small amount of debris passes then an attack may very soon come on; if a large amount passes many months or even years may pass before the tension within the cyst is sufficient to cause bursting again.

During an attack hydatid fluid and daughter cysts escape until one of the daughter cysts fall over the opening into the calyx like a ball valve.

We have had the unique opportunity of seeing this actually happen during the cystoscopic examination of a retrovesical hydatid which communicated with the bladder through an opening in the posterior wall big enough to admit the cystoscope. We looked into the living hydatid and saw the daughter cysts floating about like pearly grey spheres. When the cystoscope was withdrawn a few daughter cysts would escape then one large enough and tough enough would drop over the opening into the bladder and seal it. What happens in the bladder must happen in the kidney.

When once the hydatid has burst into the urinary tract further increase in size of the parent cyst ceases. Any increase in tension due to the natural growth of the cyst is relieved by the safety valve action of the opening into the calyx. In one of our series no alteration in size of the tumor had taken place in 10 years although the patient stated that before one of his attacks of hematuria and renal colic he thought he could feel the lump more easily.

In hydatids of the upper pole when once the liver or spleen has been invaded the safety valve action does not control further invasion of these two organs.

*Calcsified hydatids* of the closed variety as a rule produce no symptoms and they are discovered only in a routine urological examination for some intercurrent disease. Under trauma they may lead to severe hematuria but seldom if ever sufficient to justify surgical interference. A fully calcified hydatid is a dead hydatid and unless causing symptoms should be left alone.

A calcified hydatid of the open type may cause symptoms of renal colic from the passage of calcified debris down the ureter. Surgery is then indicated. Case 15 was of this type.

*Cystoscopic examination* yields the evidence of a turbid efflux from the ureter during an attack of hematuria. The mucous membrane of the bladder is seldom involved even in infected open hydatids of the kidney. In one of the series (Case 6) an acute cystitis was found but we were not convinced that there was any relationship between the calcified hydatid of the kidney and the cystitis.

In open renal hydatids routine microscopic examination of the bladder and kidney urines may reveal besides red blood cells pus cells and hydatid hooklets. What is just as characteristic and less difficult to find is fragments of laminated chitinous hydatid membrane. Nothing else resembles it.

*Functional test by phenolsulphonephthalein*. Unless gross destruction of the kidney has been brought about we have not found any difference in function between the two kidneys. In one case where the right kidney was destroyed there was a complete absence of function on that side.

*Pyelography* is of great value when a positive deformity is shown but the absence of deformity does not exclude the presence of hydatid. Kretschmer (5) published a pyelogram of an upper pole hydatid which showed deformity of the upper calyces. We show a pyelogram of a lower pole hydatid which illustrates a filling defect of one of the lower calyces. In the future we expect to be able to demonstrate some deformity in the pyelogram of all open hydatids of the kidney.

In a closed hydatid of the lower pole of the kidney no deformity of any calyx could be demonstrated. This is true of solitary cysts of the kidney which like closed hydatids when once they have reached the capsule expand like a hernia in a radial direction away from the center of the kidney. No pressure is exerted on the calyces or pelvis. If the closed hydatid is situated in the center of the kidney a deformity would be expected. We have yet to demonstrate this.

We had the opportunity of taking a pyelogram of a case in which the whole kidney had been destroyed by the hydatid. Nothing but the blind upper end of the ureter could be demonstrated opposite the second lumbar transverse process.

On pyelographic evidence there should be little difficulty in differentiating a hydatid from a solid tumor the latter cause more spider like deformity than a hydatid of the same size. Pyelography cannot differentiate between a solitary cyst of the kidney and a closed hydatid.

#### LABORATORY TESTS

*Blood count*. Much work has been done in Australia during the past 10 years to develop tests that could be relied on in the diagnosis of hydatid disease.

In common with other parasitic worms that infest the human race the echinococcus alters the relative percentage of the white cells of the blood. Welsh and Barling (8) (*Australian Medical Gazette* August 1906 383) found that the eosinophile count was increased in 50 per cent of the cases observed. This is a test that we use today and if positive it is of considerable value. One of our cases showed an increase from the normal 1 per cent to 20 per cent.

*Precipitin reaction* Welsh Chapman and Storey (9) (*Italian Medical Gazette* December 1908 6 and *Inset* April 1909 110) showed that the precipitin was derived not from the antigen but wholly or almost wholly from the antiserum.

Dew and Williams found that the precipitin test and the complement deviation test run a parallel course but the former is not so delicate nor is it quantitative in the same way. It proved positive in 100 per cent of the patients examined (1).

*Complement fixation test of Chedini* Turkey (4) has shown that the complement fixation test of Chedini is positive in 84 per cent (84.5 per cent) when tried in a series of 15 cases.

Dew and Williams (1) confirm the conclusion and showed that if this test were combined with the intradermal test for a positive finding should be obtained in 100 per cent of the cases of hydatid disease.

*Intradermal test for Chedini* Dew, Williams and Williams (1) using the intradermal test of Chedini alone found it better than the complement fixation test. It gave positive results in 9 per cent of the uncomplicated cases.

In clinical work we have found that in others that the reliability of the test depends upon the technique of the antigen. If fresh hydatid fluid from the cyst in the liver of a sheep is used, response can be put in the result. The addition of phenol to make a solution of 0.5 per cent enables the antigen to be kept for some months if placed in a refrigerator. If the antigen is old, a false positive result may appear in patients who do not suffer from hydatid disease. We have found that the error may be 10 per cent. In other words, of 20 patients who are in a general surgical ward are tested with antigen that is 1 month old, 2 may give a positive result. When the antigen is tested with fresh antigen they give a negative result. This experiment requires repetition but it is sufficient to demonstrate the weakness of these tests. In spite of this we are coming to rely more and more upon the tests of Chedini and Casoni as an aid in the diagnosis of hydatid. When a reliable antigen is obtained that will keep for at least 6 months it will be of service in all countries.

## DIAGNOSIS

In a review of our series of cases it is interesting to note the improvement in the percentage of pre-operative diagnosis since full routine urological investigations have been made. Previous to this period there were 8 cases of which were correctly diagnosed. Since full investigation has been made the rate of 8 cases were correctly diagnosed before operation. The eighth case was strongly suspected of being of hydatid nature but the complement deviation test was inconclusive and the Wassermann test was strongly positive. For the reasons a malignant or syphilitic tumor of the kidney was given preference.

It is only fair to mention that in the first 8 cases 4 were closed hydatid and 2 were open while in the last 8 only 2 were closed and 5 were open. It has been pointed out the pre-operative diagnosis of a closed hydatid is much more difficult than that of an open one. All open hydatid of the kidney should be correctly diagnosed. In 1 of the first 8 cases the hydatid was discovered post-mortem, the patient having died of acute bronchopneumonia and cholelithiasis.

In palpating kidney swelling we have adopted for more than 10 years a method of examination in which we apply with the finger the thumb end strong pressure from behind in the co to vertebral angle with the object of lifting the kidney out of its paravertebral groove while light pressure is applied in front with the other hand. This method preserves all the delicacy of light tactile examination and reveals enlargement of the kidney that otherwise would be missed. Probably many other use the same means. Spurr describes a method of lateral percussion and palpation to determine the presence of kidney swelling. This method embodies the same principle of lifting the kidney out of its groove (6).

In our experience a full clinical history and urological investigation has so far been of greater service than laboratory tests but the latter are becoming increasingly important in the chain of evidence. In closed hydatid they are of more use than in the open type. In the open type a positive diagnosis should

be arrived at without their aid. A microscopic examination during an attack of renal colic and hematuria and even between attacks should reveal the presence of hooklets or what is more common but equally characteristic a fragment of laminated chitinous cyst wall.

If when the tumor is palpated the characteristic hydatid thrill can be elicited it is a pathognomonic sign. Unfortunately it is rare and difficult to find in any part of the body and especially so in the kidney. In 1 of our 16 cases a hydatid of the lower pole in which the tumor came well down toward the iliac fossa we could elicit the thrill. We were able to secure the thrill by pressing on the medial side of the tumor with one hand and percussing on the flank with the middle finger of the other hand. The fluid and semi solid contents of the cyst gave the sensation of quivering under the percussion finger. If a cylindrical tin container with a thin top and bottom is filled with boiled starch of the consistence of *blanc mange* the hydatid thrill can be demonstrated by tapping the lid. Another material that can be used is *lummentum terebinth* (*British Pharmacopœia*).

#### TREATMENT

The recognition of the fact that there are two types of hydatid of the kidney—the open and the closed—and that each type requires different treatment simplifies the surgery of this disease. With the opportunities at our disposal we are now able to give our views upon the indications for and choice of operation with some measure of clearness.

We are satisfied that all living hydatids should be treated surgically until such time as a drug is discovered that will kill the parasite without killing the host. Tartar emetic has transformed bilharziasis from the domain of surgery to that of medicine. Let us hope that some such drug may be discovered for hydatid disease.

If untreated the disease takes a long time to kill a patient but kill him it almost certainly will. We have evidence that it can cause sudden death from embolism or anaphylaxis that it can produce intestinal obstruction that it can extend to other organs and that

during its progress it can inflict much needless suffering on the patient.

In surgical literature nephrectomy is recommended as the operation in all cases of hydatid of the kidney. We would agree with this recommendation if it were restricted to all cases of open hydatids of the kidney. If the kidney pelvis is in communication with the infected or uninfected cyst nephrectomy is indicated if it can be performed. It is surgically unsound to leave a cavity in communication with the urinary tract which if not infected previous to operation is very likely to be afterward.

In 2 open hydatids in our series nephrectomy had to be abandoned on account of severe hemorrhage when the adhesions to the liver were separated in 1 case and to the spleen in the other case. Marsupialization with drainage was carried out as the next best step. One case (Case 10) lived for 10 years and died at the age of 69 from liver pleural and pulmonary extensions of the original kidney hydatid. The other (Case 9) died suddenly 2 years afterward from hydatid embolism or anaphylaxis. The urine of both these patients was infected up to the time of death.

Closed hydatid of the kidney differs in no essential from a hydatid of the liver. Marsupialization or Lindeman's operation in some form has proved for nearly 50 years a safe sound procedure for closed liver hydatids. In our work it has proved applicable to kidney hydatids. This operation was carried out in 5 cases of closed hydatids in our series with uniformly good results both immediate and remote. A closed hydatid of the upper or lower polar region of the kidney never destroys the whole of the organ. Sufficient cortical tissue remains to justify a conservative operation.

Today improved serological tests render the task of diagnosis of closed hydatids of the kidney an easier one but if a pre operative diagnosis cannot be arrived at it is not advisable to do anything but a nephrectomy because of the risk of mistaking a malignant cyst of the kidney for a hydatid. In one case a sheep farmer had a spherical renal tumor 10 centimeters in diameter. A Ghedini and Casom test gave a negative result for hydatid disease.

yet we felt that he might still have a hydatid. When the kidney was exposed a cystic tumor was found in the middle region of the kidney that clearly resembled in appearance a hydatid cyst but it was not so tough and fibrous on palpation nor so yellowish in appearance it was more reddish in color and more cellular on palpation. As the type of tumor could not be definitely determined a nephrectomy was performed. It proved on pathological examination to be a malignant cystadenoma of the kidney. (See Fig. 3.)

Calculated hydatids of the kidney require no operation if they are of the closed type unless they give rise to repeated hematuria. We have never performed any. In the open type infection of the cavity accompanied by repeated attacks of renal colic from the passage of debris call for a nephrectomy.

Partial or subtotal nephrectomy is now established as a sound surgical procedure in certain pyogenic infection of the kidney localized to the polar region. There is no reason why it should not be applied in selected cases of hydatid of the kidney if the function of the other kidney is below normal standard or if the operation can be carried out without undue risk to the patient. The renal tissue not invaded by the hydatid is healthy tissue. Both the open and closed type of hydatid should be amenable to the treatment suggested provided there is enough normal kidney tissue left to justify the added risk of the operation.

No opportunity has yet presented itself to us to use this method of treatment but we hope to do so in the near future. We offer the suggestion to our colleagues over sea in case they may be more fortunate in getting an earlier opportunity to put this conservative method of treatment to the test.

#### OPERATION

Of the 16 cases in our series 13 were submitted to operation and 3 were not (Table I). There were no deaths due to the operation while the patients were in the hospital or after they had left the hospital.

Tapping as a therapeutic measure is obsolete for reasons already given. Lindeman (7) in 1879 described his operation for hydatid

TABLE I—SUMMARY OF SIXTEEN CASES

No.	Age	Sex	Side	Type	Operation	Result	Remarks
1	34	6	1	4	1	4	1
2	1	4	1	4	1	4	1
3	1	4	1	4	1	4	1
4	1	4	1	4	1	4	1
5	1	4	1	4	1	4	1
6	1	4	1	4	1	4	1
7	1	4	1	4	1	4	1
8	1	4	1	4	1	4	1
9	1	4	1	4	1	4	1
10	1	4	1	4	1	4	1
11	1	4	1	4	1	4	1
12	1	4	1	4	1	4	1
13	1	4	1	4	1	4	1
14	1	4	1	4	1	4	1
15	1	4	1	4	1	4	1
16	1	4	1	4	1	4	1

cyst. He exposed the cyst, emptied its contents by incision and then stitched the adventitious cyst to the abdominal wall. His operation was a full marsupialization from the incision to our kangaroo's pouch. This is the operation that with certain precautions we perform today in all cases of hydatid of the kidney which do not communicate with the renal pelvis. The type that we classify as closed provided a pre-operative drainage is made.

The precaution that we take is to prevent the oozing of the perirenal areolar tissue with cyst contents. The necessity for the precautions emphasized by the work of Dew which demonstrate the capacity of even the minute colic to produce secondary infestation.

Influenced by Edwin Beer's technique for the prevention of secondary implantation of papillomata of the urinary bladder we are using alcohol to lessen the danger of secondary hydatid infection. Any surgeon familiar with Beer's technique in suprapubic cystotomy for bladder papillomata could operate with confidence in hydatid disease of the kidney provided he followed the same principle.

We expose the cyst at its most superficial part—usually this is in the loin. If it is in front near the iliac crest we make a muscle splitting incision as for an appendix but avoid going through the peritoneal cavity. When the cyst is exposed it is seized with Allis forceps and a trocar attached to a suction apparatus is plunged toward the center. As the contents are evacuated the cyst wall is drawn well up into the wound and packed off with dark colored gauze preferably black to facilitate the recognition of the contents that may escape. The fluid drawn off is measured and an amount of alcohol slightly less than that injected into the cyst where it is left to act as a devitalizer for 3 to 4 minutes. The alcohol is then withdrawn and the cyst contents

evacuated through an incision made at the site of the trocar puncture. An instrument shaped like a long handled teaspoon or table spoon is useful in removing the numerous daughter cysts. It sometimes takes half an hour to three quarters of an hour or longer to clean out a large cyst thoroughly. A wide bore suction apparatus is also of help in cleaning the recesses. When this cleansing is accomplished we again treat the collapsed cyst by swabbing it out with alcohol. Before the cyst is incised or after it is emptied the adventitious cyst wall is stitched to the deep aspect of the abdominal muscles with chromicized catgut that will last for 14 days at least. The incision in the cyst is left open. The abdominal wound is then closed in layers with a small rubber dam drainage down to but not into the cyst. This drain is removed in 3 or 4 days if all goes well. Sometimes the cyst drains freely for a longer period when this occurs we allow the rubber dam to remain longer. We have given up the use of large calibered rubber tube drains as they lead to postoperative infection. If the cyst is large and communicates with the liver or spleen we make an exception and use large tubes. Under such circumstances daughter cysts may be discharged through the tube for many weeks as it is impossible to evacuate the irregular cavity thoroughly if the cyst proves to be of the branching loculated type.

The safest method of all to prevent the escape of cyst contents into the perirenal tissue is a two stage operation. At the first step the cyst is exposed by the usual method and stitched to the abdominal wall. The wound through the abdominal muscles is left open and packed with gauze. Ten to 14 days later when adhesions have shut off the surrounding areas the cyst is evacuated as described.

The two stage operation has been successfully used in hydatid of the brain and certain deeply situated abdominal hydatids. Up to the present we have not seen the occasion to use it in hydatid of the kidney.

Formalin in 10 per cent solution is used by some Australian surgeons in the same way as we use alcohol to devitalize the parasite. It is claimed to be quite satisfactory.

The Bond Delbet Posadas operation in which the cyst is opened evacuated and allowed to drop back without being stitched to the abdominal wall we have not done. While many brilliant results by primary healing have followed this method there have been in Australia sufficient postoperative deaths from leakage and infection to restrain us from attempting it. With all the precautions that are taken it is difficult to be sure that every scolex has been destroyed by the alcohol or formalin. If the cyst is dropped back without being secured to the abdominal wall any living scolex will lead to a secondary implantation in the deep perirenal tissues if it is stitched to the abdominal wall implantation can take place only in the superficial scar tissue. This complication arose in one of our series (Case 10). We had no difficulty in excising completely the whole cyst with some surrounding scar tissue.

The operation of nephrectomy through the usual oblique lumbar incision presents no more difficulties in hydatid disease than it does in any other disease of the kidney.

The opportunities of studying the clinical aspects of hydatid disease that have fallen to the lot of the surgical staff of the Royal Prince Alfred Hospital particularly during the past 50 years are unlikely to occur again in the same space of time.

It is with the object of placing one phase of this disease before our colleagues in other countries that this communication has been given. At the same time we wish it clearly understood that we are giving our own personal views and do not imply that they necessarily represent the views of other members of the surgical staff.

CASE 1 C S female age 1 years. Family history good no previous illnesses. For the past 2 years patient has had dragging bearing down pain on the right side of the abdomen attributed to heavy work. The pain has been worse during the last 10 months has been constant and worse after exertion. It is confined to the right side of the abdomen and to the right loin. Attacks of vomiting have occurred 5 and 3 weeks ago. During these attacks there has been marked increase of pain in the right side of abdomen and right loin. During the last few months there has been increased frequency of micturition accompanied by occasional scalding three to four times during the day twice



at night There has been hematuria on 4 occasions during the last few months bright red and in tumtely mixed with the urine Examination of the urine showed red count on acid specific gravity 1.05 faint cloud of albumin a few pus cells A large round tumor extending from the right iliac to almost the malleolus from it as dull percussion a firm donor pirant Operation consisted of a lumbar photomythigh which the contents of the cyst were of innumerable daughter cysts and multiplocystic The edge of the abdominal cyst as it held to the abdominal wall and a tubular incision followed with discharge from hospital 7 days after paracentesis in the left Groin condition excellent

CASE R. C. Miller age 43 years Female history of long period of the menstrual cycle treated Ten days ago had a severe pain in the right iliac region which was reduced by rest and mild analgesics The following day the pain became more severe and the patient was unable to get up Further abdominal examination showed a firm mass in the right iliac region for 2 weeks On palpation the mass was tender and the left iliac region was normal The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up

The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up The mass was enlarged and the patient was unable to get up

Case 3 C. K. Hepler age 26 years He had no previous illness The previous history of the front of the abdomen to the left groin was mitting occurred during the attack Twenty four hours later he passed in the urine a substance resembling grapekins The urine was bloody and strained Since that time he has had similar attacks occurring lately at more frequent intervals and in some of these intervals the patient has extended into the testicles Examination shows a healthy muscular

man No definite tumor of the left kidney could be demonstrated Pathological examination of the urine showed it to contain pus and blood No hooklets in Blood examination showed the precipitate for hydatid fluid positive A left lumbar nephrectomy as performed The lower pole of the kidney was occupied by a hydatid cyst about 3 inches in diameter filled with daughter cysts It was discharged from the hospital 5 weeks after the operation The wound was healed

CASE M. J. L. female age 33 years Lived all her life in the country Two weeks ago had a large profuse flow of vomiting diarrhoea and urine These symptoms have persisted ever since In the last 12 months she has noticed a hard lump in the left hypochondrium with a dragging bearing down pain which gets worse on exercise She thought of illness there has been an increase of frequency of micturition accompanied by scalding of the urine dark in color On examination of the patient jaundice with a hard rounded tumor situated in the left hypochondrium movable on manual examination Cystoscopy showed the efflux of the right ureter clear that from the left tubular and bloody There were pus and casts in both specimens removed on the left side Blood examination showed 10 percent eosinophilia No previous performance of the last 2 weeks after admission Physical examination showed bronchopneumonia a cholelithiasis and in both kidneys an aneurysm of the lower pole of the left kidney occupied by a spherical hydatid cyst containing numerous daughter cysts but no communication as far as the urinary pelvis

CASE V. M. O female age 10 years Patient had a lump in the city When she was 4 years of age she had an operation for tumor of the liver which was removed One year before admission she had acute right renal colic and 1 month later she noticed a movable lump in the right hypochondrium Nothing was done on account of the fact that she was 4 months pregnant Since the birth of the child the pain has become more severe and of a dull dragging character and the lump has increased in size Examination showed the enlarged rounded lump in the right hypochondrium which was felt manually and moved on respiration The urine contained no albumin sugar or pus Blood examination percent eosinophilia Through a right lumbar nephrotomy a hydatid cyst with numerous daughter cysts was removed The edge of the live tissue cyst was closed to the abdominal wall Convalescence was slow The patient was discharged 18 weeks later with sinus still draining

CASE W. H. B. male age 67 years Patient had an attack of hematuria 6 weeks ago of sudden onset accompanied by scalding and pain in the groin The penis This continued more or less until 10 days ago when the symptoms almost completely subsided X-ray examination showed a typical calcified hydatid in the right kidney Cystoscopic examination showed a marked cystitis still present

Examination of the urine showed pus cells red blood cell and motile organisms. The attack of cystitis completely subsided after weeks rest. As this attack of cystitis had no apparent relation to the calcified hydatid in the right kidney no operation was advised.

CASE 7. G. C. male age 58 years. Patient has lived at times in the sheep country since childhood. He is said to have had hydatid disease of the liver 8 years ago and 9 years ago. Three days ago he had a sudden acute pain in the left iliac region which was colicky in character. Urine at this time was as dark as treacle stools were light in color. He vomited a month ago. He had some slight pain on micturition with increased frequency. Examination showed patient very jaundiced with tenderness in the right hypochondrium and the liver 4 inches below the costal margin. On the left side of the abdomen there was a tumor about 3 inches in diameter movable on respiration with its lower margin at the level of the iliac crest. A muscle splitting incision was made at the level of the iliac crest and a retroperitoneal tumor was found arising from the lower pole of the kidney. This was opened and hydatid and daughter cysts were removed. The adventitious cyst was sewed to the abdominal wall and a drainage tube inserted. Patient was then turned on his left side and a trans thoracic hepatic omy performed in the midaxillary line at the level of the tenth rib. The hydatid cyst was marsupialized after removal of its contents. Convalescence was slow. Patient was discharged 9 weeks afterward. Kidney wound had closed but the hepatic wound was still discharging.

CASE 8. W. McD. male age 9 years. Patient had had no previous illnesses. For the past 6 months the mother has noticed that there has been a swelling in the right side of the abdomen which has increased in size from the time it was first noticed. The child has never complained of any pain and has been perfectly well in health. The urine has never shown any alteration from the normal. Examination showed a rounded swelling 3 inches in diameter in the right hypochondrium. Ten e dull on percussion which moved on respiration. A muscle splitting incision was made over the most prominent part of the swelling. The contents of the cyst were aspirated then it was opened and the daughter cysts and the endocyst removed. The margin of the adventitious cyst was then stitched to the peritoneum and the abdominal wall and a rubber tube drain inserted. Five weeks afterward patient was discharged from the hospital with a small sinus still discharging.

CASE 9. S. A. W. male age 38 years. Patient lived in sheep country in his childhood and in the city during adult life. He has had no previous illnesses. Nine months ago he had a sudden severe colic like pain in the left lumbar region. He was ill for 3 weeks. During this time he vomited once or twice a day. The urine was blood stained at intervals during this initial attack. He was well for 3 months and a similar attack of left sided pain

occurred but there was no vomiting. Patient has had a constant dull dragging pain ever since in the left loin. Five weeks ago there was a slight recurrence of the hæmaturia no increase of frequency. At intervals during the last 5 weeks he has noticed that the urine has contained a substance like jelly fish. The lower pole of the left kidney is palpable but not definitely enlarged.

Macroscopical urine examination showed collapsed daughter cysts present microscopic examination showed laminated membrane hooklets pus and blood.

The patient left the hospital at his own request and returned a year later. He remained well until 4 months ago when he noticed discomfort after eating accompanied by flatulence and pain in the left hypochondrium and left loin no vomiting. During the last 8 weeks he has passed grape skins in the urine. Examination showed that the lower pole of the left kidney is still palpable but not more clearly than it was 12 months ago. Urine contained pus cells red blood cell and hooklets. Blood examination showed 6 per cent eosinophilia. Urine from right kidney decreased with cysto cope contained no abnormal elements. No urine could be obtained from the left kidney although there was a turbid efflux from this ureter before the passage of the catheter. The left kidney was exposed and a hydatid cyst was found involving the upper pole of the kidney extending nearly to the vertebral column and upward to the diaphragm. Anteriorly it was adherent to the spleen and when an attempt was made to separate these adhesions a sharp hemorrhage occurred. For this reason the cyst was aspirated and its contents evacuated. The cyst wall was then marsupialized. The contents consisted of daughter cysts and endocyst intermingled with purulent fluid. Two years after operation he took a fit in a railway train and died within 10 minutes. No post mortem examination was made.

CASE 10. S. R. female age 59 years married 5 years 6 children youngest age 15. Patient has lived all her life in the country. Her husband is a sheep farmer. Both her parents lived over 80 years. Menstruation ceased at 46. No previous illnesses. Eight months ago patient had an attack of renal colic and pain extended from the right loin to the vulva. Pain was accompanied by slight hæmaturia. The urine was dark in color and the patient noticed in it bladder things about the size of a green pea. There was nothing more until 3 weeks ago when she noticed a number of similar things in the urine. Examination showed in the right hypochondrium a rounded tumor palpable on deep inspiration which slipped back out of reach on expiration. An X-ray examination of the right kidney showed a large shadow suggestive of kidney tumor. Cystoscopic examination showed flakes of mucus floating in the bladder. The mucous membrane showed generalized mild cystitis. The right ureteral orifice was oedematous and swollen the left was normal. A catheter was passed to the pelvis of each kidney.



97 per cent ethyl alcohol and was explored with the finger. No communication with the pelvis could be found. We completed the operation by allowing the wall of the cyst to collapse and the opening in the cyst was closed with a continuous plain catgut suture. The cyst itself was then sewed to the margin of the wound so as to anchor it. The muscles and surrounding tissues were closed in layers with a rubber tube drain at the lower angle of the wound leading down on to the closed incision in the cyst. The drain was removed in 3 days and the wound was completely healed by first intention in 2 weeks. Patient was discharged from the hospital 2 weeks after operation. He returned to duty 1 month after leaving the hospital and worked for 9 months continuously. He had some pain at the site of the wound after a hard day's work. Ten months after operation the wound was soundly healed and he looked in perfect health. Urine showed no albumin no sugar microscopically no pus no red blood cells.

CASE 1. J. R. male age 50 years married. Water works engineer. Father died at 41 of Bright's disease. Mother died at 48 from an aneurism. Patient lived in the country as a child. Was at sea for 10 years. Had spirochaete infection at the age of 30. Has been ailing for the last 3 months with a dull dragging feeling in the left hypochondrium aggravated by driving in a motor car. Seven weeks ago after a long drive he felt a lump in the left side of the abdomen for the first time. He has noticed that he gets some shortness of breath on going up stairs no swelling of the feet. No loss of weight. Examination showed a cystic swelling in the left hypochondrium extending into the left loin. The lower margin of the swelling is on the level of the iliac crest and extends to within 2 inches of the middle line. Urine showed no albumin no sugar microscopically no pus 1 red blood cell to a field 1/6 objective. Cystoscopic examination showed early trabeculation of the bladder walls no cystitis. There is early intravesical enlargement of the prostate. Differential phthalein test returned from the right kidney 6 per cent in half an hour from the left 5 per cent in the same time. The left kidney specimen showed an occasional pus cell and red blood cells. Phthalein test gave 30 per cent in the first hour and 10 per cent in the second making a total of 40 per cent. Pyelogram was not taken on account of breakdown of the X-ray plant. An X-ray taken previously showed a rounded tumor in the region of the left kidney with a protuberance from the general outline of the tumor at its lower pole. This protuberance reaches the level of the iliac crest. The lower pole of the main tumor shows an increased density suggestive of early calcification. Wassermann test triple positive. Blood count showed neutrophils 73 per cent lymphocytes 19 per cent eosinophils 2 per cent transitional and large mononuclear 0 per cent basophils 1 per cent. Complement fixation test for hydatid gave doubtful outcome. Pathological report in view of the positive Wassermann test the absence of eosinophils and the presence of leucocy-

tosis a hydatid infection is not suggested. A left nephrectomy was done through an oblique lumbar incision. The upper pole appeared to be normal the lower half was occupied by a cyst more or less spherical in outline  $4\frac{1}{2}$  inches in diameter. The cyst was fixed in formalin solution before being opened. It was sectioned 1 month later and proved to be a hydatid cyst. There was no evidence of suppuration but it was tightly packed with daughter cysts. The wound healed by first intention and the patient left the hospital 19 days after the operation. He has been quite well and at work ever since.

CASE 13. W. D. age 30 years male married builder. Patient has lived in the country all his life but has not raised sheep for 10 years. He has had attacks of hæmaturia for the past 12 years. The first attack was colic like in character and the pain extended from the right loin down to the right groin. These attacks at first were at intervals of about 6 months but lately have been more frequent. As far back as 12 years ago he passed a little bladder stone in the urine following one of these attacks of pain and hæmaturia. At times he is able to trace the track of the pain down from the kidney toward the bladder region and when it reaches there he gets relief. The passage of the cysts through the urethra causes no discomfort merely a temporary stoppage in the stream. As he is a house builder his estimate of the size of the cysts that he has passed is probably correct. He states that he has passed cysts varying in size from  $\frac{1}{8}$  to  $\frac{3}{4}$  of an inch and when passed into a vessel they appear spherical in outline although they emerge from the meatus in an elliptical form. The hæmaturia has been more marked of late accompanied by clots. He estimates that in the last attack which occurred 14 days before admission he lost about half a pint of blood. No cysts have been passed during the past 3 months. Icthotest returned 45 per cent first hour 5 per cent second hour total 50 per cent. Cystoscopic examination of bladder wall showed a very slight injection of the mucous membrane. Both ureters were catheterized to the pelves without obstruction. Specimen from the right side showed a trace of blood (traumatic) that from the left was slightly turbid. A plain X-ray picture of the upper tract showed an increase in the left kidney shadow. A pyelogram showed a filling defect involving the lower calyces. When the patient was examined 10 years previously by a surgeon his attention was drawn to a lump in the left side of the abdomen which he states has not increased in size although he thinks that before an attack of hæmaturia comes on it gets a little larger. There has been no increase of frequency of micturition no pain even when passing cysts. Urine shows faintly cloudy albumin left kidney specimen contains pus red cells and fragments of laminated membrane. Examination shows the lower pole of the left kidney definitely enlarged when it is felt manually. Differential blood examination shows neutrophils 61 per cent eosinophils 5 per cent lymphocytes 30 per cent large mononuclears 4 per



round the middle calyx. Patient made an uninterrupted recovery and since the operation has gained five stone (10 pounds).

#### SUMMARY

1 Hydatid is a disease of wool growing countries. The United States and Canada are gradually coming under this classification.

2 As it takes 15 to 20 years from the time of infestation for hydatid disease to manifest itself it will be the rising generation of surgeons of North America who will be interested.

3 There are two types of hydatid of the kidney: (a) the open type which communicates with the renal pelvis and (b) the closed type which has no communication with the renal pelvis.

4 The diagnosis of the open type is comparatively easy if a full clinical and urological examination is made but the diagnosis of the closed type is difficult and requires the aid of the intradermal test of Carson or the complement deviation test of Ghedini.

5 Nephrectomy is the operation of choice in open hydatids. Marsupialization or ne-

phrostomy after devitalizing the contents of the cyst with alcohol or formalin is the safest and best operation for closed hydatids.

6 Subtotal nephrectomy may prove a useful operation when the function of the other kidney is poor.

NOTE.—Those interested in the subject of hydatid disease will find full and exhaustive references to the literature in the monograph "Hydatid Disease" by Harold Dew, Australian Medical Publishing Co. 1921.

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cystic type this patient should continue in good health and it is unlikely that other similar lesions will develop. Probably trauma was the important factor in the production of the lesion in this instance.

CASE 1. A girl aged 13 years, also of Jewish extraction, admitted November 15, 1926. Her family history was negative for tubercular infection. Her previous history was that she was ill with influenza in the summer of 1925, and that she had been removed to the hospital for treatment of the disease. She was then found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged. She was then found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged.

At the time of admission, the patient was found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged. She was then found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged. She was then found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged.

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a specific gravity of 1031, acid reaction and occasional red blood cells. On examination of the eyes vision was 6/10 on the right and 6/6 (with correction) on the left. The pupils were equal and reflexes and fields were normal. The examination of the fundus was negative. Examination of the ear, nose and throat was negative.

Roentgenogram of the cervical spine revealed a cystic like tumor situated posteriorly and to the left, apparently springing from the second and third cervical vertebrae (Figs. 1 and 2). Roentgenogram of the chest was negative.

Cervical myelogram examination failed to reveal any disturbance in either the cranial or the spinal nerve. Spinal puncture was made at the fifth thoracic level of injury with subsequent extension and the shell like appearance of the tumor brought out in the roentgenograms. I felt that it was a cerebrospinal fibrous cyst of the cervical spine and in view of my experience in the removal of a high paralysis developed in a child.

The patient was found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged. She was then found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged. She was then found to have a cystic lesion of the thyroid gland, and was operated on for it. The operation was successful, and she was discharged.

Convalescence was uneventful and the patient was discharged on February 1, 1927. She returned for re-examination and was found to be perfectly well. There was no limitation of motion. She did not complain of neurological symptoms as did from sick headache similar to those which she



Fig 1 Roentgen of the tenth dorsal vertebra on the right

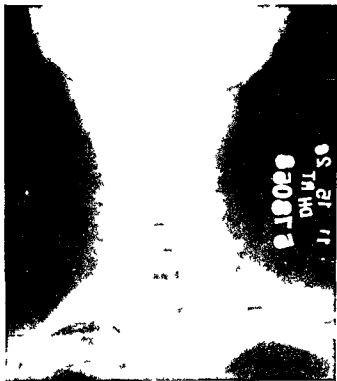


Fig 2 Foreign body giant cell tumor of the upper cervical area (anteroposterior view)

had had previous to the injury and which apparently were of the nature of migraine the mother too is subject to migraine headaches. The cervical spine was again examined roentgenologically. There was no evidence of tumor only slight asymmetry in the cervical spine was present.

This case is worthy of consideration since a lesion like that in Case 1 would have progressed no doubt until complete transverse myelitis had developed. Again trauma and infection were etiological factors in the production of the tumor. The roentgen ray examination was of extreme value since it demonstrated the shell like tumor which made the diagnosis of foreign body giant cell tumor possible and encouraged us to perform the second exploration.

#### DISCUSSION

Lewis in reporting his case reviewed briefly the histories of 16 additional cases all of which were similar to the I have presented. With one exception all of the patients were between the ages of 7 and 25 years.

In attempting to differentiate foreign body giant cell tumor and malignant tumor of the spine especially in children and young adults



Fig 3 Lateral view of tumor shown in Figure 2. The fibrocystic nature and its attachment to the second and third cervical vertebrae are shown. The shell like appearance of the tumor and cystic areas containing irregularly placed spicules of bone are evident.







Fig 1 Erosion of the tenth dorsal vertebra on the right



Fig 2 Foreign body giant cell tumor of the upper cervical area (anteroposterior view)

had had previous to the injury and which apparently were of the nature of migraine the mother too is subject to migraine headaches. The cervical spine was again examined roentgenologically. There was no evidence of tumor only slight asymmetry in the cervical spine was present.

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## THE VALUE OF VENTRICULAR STUDIES OTHER THAN VENTRICULOGRAPHY IN THE LOCALIZATION OF BRAIN TUMORS<sup>1</sup>

By FRANCIS C GRANT M D PHILADELPHIA

I tru t S y U rsty f P y l an M d ls hool

NO single factor is more vital to the successful extirpation of a brain tumor than precision in its localization. If the position of the neoplasm is accurately known the operative maneuvers necessary to its removal may be carried out with a much greater chance of success. The methods of determining that region of the brain involved by the tumor are many and varied. A careful detailed history with the chronology of the onset of the symptoms plus routine neurological studies, retinoscopic examinations and visual perimetric tests coupled with vestibular studies and roentgenoscopic films will furnish in the majority of instances clear cut evidence of the site of the neoplasm. However in a certain number of cases although the presence of a tumor is unquestioned no definite clue can be obtained as to its situation. Heretofore to solve this problem of the unlocalizable brain tumor a ventriculogram was necessary. But as experience with ventriculography increased the effect upon the size shape and position of the ventricles of tumors placed in different brain areas became more clearly appreciated. It soon became apparent that if a definite routine were adopted in the tapping of the lateral ventricles the estimating of the amount of fluid removed from each and the determining by injection of a dye whether the interventricular foramina were patulous

a very shrewd guess could be made as to the abnormality in the ventricular outline that the X ray films would subsequently reveal. This procedure of attempting to determine the position of the lateral ventricles by plunging for them from a fixed point of estimating their relative size by the amount of fluid recoverable from each and lastly of discovering whether or not the interventricular foramina are patulous by the injection of a dye has been termed by Dandy (1) ventricular estimation. It is a logical outgrowth of his brilliant conception of cerebral pneumography. Since bilateral ventricular tap without the replacement of the fluid by air is unquestionably safer than ventriculography this has seemed sufficient justification to attempt to discover the value and the limitations of this less hazardous method of tumor localization.

Four conditions must be met in order to draw accurate conclusions from ventricular estimation. It is necessary to appreciate clearly the effect upon the ventricular system of a tumor in different regions of the brain. The operator should be thoroughly familiar with the normal position size and depth from the surface of the lateral ventricles so that he can be certain that a failure to reach either of them is due to an abnormality in their outline and not to an error in his technique. The patient must be sufficiently cooperative to permit of a complete neurological study so



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that by obtaining normal response from the different brain area it can be determined which of them because of their unimpaired function are obviously uninvolved by the tumor. Lastly the possibility of error inherent in this method must be grasped so that if necessary air may be introduced to outline the ventricle accurately if the evidence from an estimation alone seems inconclusive.

Broadly considered brain tumors produce two types of changes in the ventricular system—symmetrical or asymmetrical variation in the size, shape, and position of the lateral, third, and fourth ventricles. Symmetrical dilatation of the lateral ventricles is always due to an internal hydrocephalus set up by a tumor obstructing the free circulation of the cerebrospinal fluid. To produce such an effect a tumor must be situated in the midline between the cerebral hemisphere, either in or impinging upon the third ventricle supratentorially or in the posterior fossa (Fig. 1). Ventricular estimation under these circumstances would reveal the lateral ventricles in normal position or nearer the cortex than usual. Both ventricles should show an increase in fluid content to approximately the same degree. Dandy states that it is necessary to obtain at least 30 cubic centimeter of fluid by free flow or a piration from each ventricle to be safe in inferring that a hydrocephalus exists.

It is particularly in cases of hydrocephalus that injection of indigo-carmin dye into one

lateral ventricle may give important information. If under these conditions this indicator be injected into one lateral ventricle and cannot be recovered from the other, this is good evidence that the interventricular foramina are obstructed and that the tumor lies in this region.

Asymmetrical variations in the ventricular outline are always due to a tumor lying within one cerebral hemisphere and causing a shift in the position of one or both lateral ventricles with filling defects in the outline or even complete obliteration of the ventricle lying within the hemisphere involved (Fig. 2). Such changes are due to direct pressure from the neoplasm and not to secondary effects from interference with cerebrospinal fluid circulation. Under these conditions it may be impossible to introduce the exploring cannula into one or the other lateral ventricle. If both can be tapped, the ventricle on one side contains much more fluid than its fellow—definite evidence of their inequality in size.

The ventricle should always be tapped from the same relative position. It is only through the development of an accurate technique in



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introducing the cannula that positive evidence of changes in their position may be determined. Bilateral trephine openings are made 7 centimeters above the occipital protuberance and 1.5 centimeters lateral to the midline to avoid the longitudinal sinus. The cannula is directed to enter the vestibule of the lateral ventricle its widest point. The occipitoparietal approach is used because the cannula passes through a relatively silent cerebral area well behind the sensory cortex and above the visual tracts. From this position the ventricles should be encountered at a depth of from 4 to 5 centimeters, the cannula being directed slightly outward and in a horizontal plane level with the tip of the ear. A shift in the position of a ventricle may be demonstrated by variations from the normal planes necessary to enter it with the cannula.

A complete neurological examination performed upon a cooperative patient is necessary to obtain the most accurate results from ventricular estimation. The negative evidence

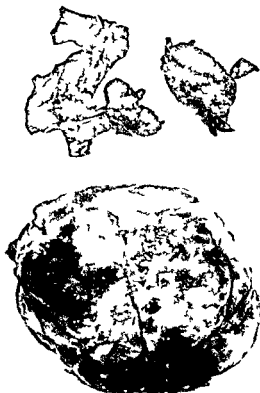


FIG. 3. Tumor removed from Case 1.



FIG. 4. X-ray of Case 1 one year postoperatively after retapping of the cyst and replacing the fluid with air. The position of the cyst in the left frontal lobe is clearly shown.

of unimpaired functions from various cortical areas demonstrating that they are probably not involved by the tumor must always be considered. For example if it can be shown definitely that one lateral ventricle is much smaller than the other obviously the tumor cannot be cerebellar or in the third ventricle because a symmetrical hydrocephalus does not exist. The neoplasm must lie in that cerebral hemisphere harboring the smaller ventricle. And if all the active cortical areas of that hemisphere function normally the tumor must be located in a silent area for example the frontal lobe or the right temporal lobe.

In many instances where the clinical evidence is open to more than one interpretation as to the location of the tumor for example when doubt exists as to whether the lesion is in the frontal lobes or cerebellum ventricular estimation may clear up the situation at once by determining the presence or absence of hydrocephalus. Once it is known whether the tumor lies above or below the tentorium the proper localizing symptoms may be stressed while the confusing signs can be confidently rejected.

In a series of 26 cases in which ventricular estimation had been employed as an aid in diagnosis 19 were subsequently verified at operation or necropsy. Our interpretation of the findings was correct in 18 instances, incorrect in 1 instance. One death occurred in a patient already stuporous from high intra-

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It is particularly in cases of acute inflammation that injection of indol is

introducing the cannula that positive evidence of changes in their position may be determined. Bilateral trephine openings are made 7 centimeters above the occipital protuberance and 1.5 centimeters lateral to the midline to avoid the longitudinal sinus. The cannula is directed to enter the vestibule of the lateral ventricle at its widest point. The occipitoparietal approach is used because the cannula passes through a relatively silent cerebral area well behind the sensory cortex and above the visual tracts. From this position the ventricles should be encountered at a depth of from 4 to 5 centimeters, the cannula being directed slightly outward and in a horizontal plane level with the tip of the ear. A shift in the position of a ventricle may be demonstrated by variations from the normal planes necessary to enter it with the cannula.

A complete neurological examination performed upon a cooperative patient is necessary to obtain the most accurate results from ventricular estimation. The negative evidence

Fig. 4. X-ray of Case 2 one year postoperatively after retapping of the cyst and replacing the fluid with air. The position of the cyst in the left frontal lobe is clearly shown.



of unimpaired functions from various cortical areas demonstrating that they are probably not involved by the tumor must always be considered. For example, if it can be shown definitely that one lateral ventricle is much smaller than the other, obviously the tumor cannot be cerebellar or in the third ventricle because a symmetrical hydrocephalus does not exist. The neoplasm must lie in that cerebral hemisphere harboring the smaller ventricle. And if all the active cortical areas of that hemisphere function normally, the tumor must be located in a silent area, for example, the frontal lobe or the right temporal lobe.

In many instances where the clinical evidence is open to more than one interpretation as to the location of the tumor, for example, when doubt exists as to whether the lesion is in the frontal lobes or cerebellum, ventricular estimation may clear up the situation at once by determining the presence or absence of hydrocephalus. Once it is known whether the tumor lies above or below the tentorium, the proper localizing symptoms may be stressed while the confusing signs can be confidently rejected.

In a series of 6 cases in which ventricular estimation had been employed as an aid in diagnosis, 19 were subsequently verified at operation or necropsy. Our interpretation of the findings was correct in 18 instances and correct in 1 instance. One death occurred in a patient already stuporous from high



Fig. 3. Tumor removed from Case 1.





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cranial pressure due to a large infiltrating glioma.

The following are illustrative of the value of ventricular stimulation. That the 3 cases should all have harbored frontal lobe tumor is not a matter of chance. The frontal lobe is silent brain area. Lesion in other regions of the cerebral hemisphere usually produce definite clinical symptom which make localization possible by ordinary method.

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settled the disputed point concerning the position of the tumor. Dr. Torgerup performed a unilateral extirpation on May 1, 1907. Bilateral tracheal

openings were made over the vertex. The left ventricle could not be reached. The right ventricle was readily tapped and 20 cubic centimeter of fluid were obtained. The left ventricle was therefore obliterated. Asymmetrical lateral ventricles existed and the tumor could not be located in the posterior fossa. A left frontal craniotomy was therefore performed and a large meningioma (Fig. 3) arising from the left olfactory groove was removed. Convalescence was uneventful. Sufficient vision was regained in the right eye for the patient to see to thread a needle.

It is in the differentiation between subtentorial and supratentorial tumors that ventricular estimation is of especial value. Once ventricular asymmetry has been determined the tumor is known to lie above the tentorium.

**CASE.** Marked evidence of intracranial pressure without definite localizing signs. A ventricular tap showed that the left ventricle was obliterated. A left frontotemporal flap was turned back and a gliomatous cyst was exposed and evacuated.

**R. B. a Jewish housewife** was referred to the University Hospital on July 2, 1925 complaining of weakness and loss of vision. She had been entirely well until December, 1914, when she began to suffer from very severe frontotemporal headaches. Early in 1925 rapid failure of vision followed. In March, 1925 a right subtemporal decompression was done at another hospital in an attempt to preserve vision. Following this procedure the headaches disappeared but the visual loss steadily progressed. There has been no evidence of motor loss or convulsions but 6 weeks before admission a transient attack of unconsciousness occurred. There was some mental deterioration with a thick uncertain speech and drooling of saliva. During the preceding week she had become much weaker and had difficulty in getting about. Her gait while weak had never shown any suggestion of staggering. She had much difficulty in swallowing solid foods.

**Physical examination** revealed an undernourished woman rather uncooperative and silly in her talk. Her gait while weak was not abnormal. No Romberg sign was noted. Her memory was much impaired. The speech was rambling and occasionally disjointed but the presence of actual aphasia seemed questionable. There was a fair sized tense hernia cerebri on the right. The cranial nerves were negative except for questionable bilateral loss of sense of smell. Occasional lateral nystagmoid movements of the eyes in both directions and bilateral choked discs of 5 diopters. The fundi were full to rough tests. The extremities revealed uniform weakness without sensory loss. No dysmetria, ataxia, adiadochokinesia or astereognosia could be demonstrated. All reflexes were equally exaggerated. A bilateral Babinski, Oppenheim and abortive ankle clonus were noted. The roentgen ray studies were negative. A diagnosis



FIG. 7. Ventriculogram as in the effect of the tumor. T of the left lateral ventricle on the ventricular system. Ventricular tap alone and the estimation would have led to error in diagnosis because symmetrical hydrocephalus could have been found and a subtentorial lesion suspected. Localization of the tumor was determined by ventriculography and achieved by the removal of the tumor at operation.

of cerebral tumor was made but with uncertainty as to laterality.

Doctor Grant attempted a bilateral ventricular tap through the parieto-occipital approach on July 8, 1925. The right ventricle was found to be in a normal position and contained 24 cubic centimeters of fluid. The left ventricle was reached but only 2 cubic centimeters of fluid could be obtained. Pressure over the hernia cerebri seemed to increase the flow from the right ventricle but not from the left. **Impression**—asymmetry of lateral ventricles with obliteration of left ventricle in silent area of left cerebral hemisphere.

On July 14, 1925 a left frontal flap was reflected revealing a large gliomatous cyst. An evacuation of the cyst (Fig. 4) was carried out with treatment of cyst wall with Zenker's fluid and removal of part of the deep lying tumor for pathological identification. This was followed by a decompression at the base of the flap. The patient recovered and was discharged. A pathological diagnosis of oligodendroglioma was made (Fig. 5).



(Fig 7) shows the hydrocephalus produced by a tumor lying within the left lateral ventricle. Had only an estimation of the size of the ventricles been made the conclusions based upon the test would have been grossly misleading. Furthermore the differentiation between midline supratentorial and posterior fossa lesions is not possible by bilateral tap alone for both produce symmetrical hydrocephalus. The only method by which this distinction can be made is through air injection and a determination of the presence or absence of air in the third ventricle. Furthermore this differentiation is of importance because the operative approach to the two regions is so radically different.

In any intracranial procedure release of intradural tension by ventricular tap will reduce hemorrhage and make possible a proper approach to the lesion thus greatly facilitating its extirpation. It is always a wise precaution therefore to know something of the size of the ventricle before attacking any tumor no matter how positively its position may be known. Furthermore if in a suspected cerebellar case a tap for relief of pressure fails to demonstrate a hydrocephalus the operator must be very certain

of his ground on clinical or other evidence before he explores the posterior fossa for in the presence of increased pressure cerebellar tumors always cause hydrocephalus.

#### CONCLUSIONS

1 Ventricular estimation is a safer procedure than ventriculography. In experienced hands with proper interpretation it may often give information of equal value.

2 Asymmetry of the lateral ventricle is very strong evidence of a cerebral tumor on the side of the smaller ventricle.

3 A symmetrical hydrocephalus usually indicates a cerebellar tumor. However it is under the circumstances that an error may be made from ventricular estimation alone unless the clinical syndrome points to the cerebellum. If doubt exists it is wiser to perform a ventriculogram in the presence of hydrocephalus.

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# CLINICAL SURGERY

FROM THE CHICAGO HYGIENIC HOSPITAL

## THE TREATMENT OF OCCIPUT POSTERIOR POSITION AFTER INCARCINATION OF THE HEAD

By JOSEPH B. DE LEE, M.D., F.A.C.S., CHICAGO

In a short article on technique it is not possible to cover the whole subject of the treatment of occiput posterior position and therefore I have selected one phase of it, the most common one, what to do after the head has engaged in the pelvis but anterior rotation of the occiput has failed to take place, indeed the occiput may have turned further back and after descent and has come to rest in the hollow of the sacrum with the small fontanel in the median line.

In order to lend a little scientific precision to our description of the various positions the presenting part occupies in the pelvis I have recommended that we name these positions according to the degrees of a semicircle, the zero point being the pubis. Thus when the occiput lies at a just described we would term it an occiput 120 degrees right or left depending on which side the occiput came down. Occiput right transverse would be O.D. 90 degrees, occiput left anterior O.L. 45 degrees etc.

As a rule in practice we find that a head which comes into the pelvis O.D. 135 degrees or O.L. 135 degrees (i.e. O.D.P. or O.L.I. respectively) will at given time enough rotate; sometimes the rest of the half circle and come to lie O.D. 5 degrees or O.L. 5 degrees or so, i.e. whence it will be delivered spontaneously or by the aid of a simple forceps operation. Since this may require many hours of labor the accoucheur should support the parturient's power with food especially sugars and fluids and with rest and sleep. Morphine and scopolamine, morphine and magnesium sulphate with or without either rectal instillation are to be used generously. The bag of waters must be preserved as long as possible and ruptured only after complete dilatation of the cervix has been obtained. There are exceptions to this rule but they are rare. The patient should lie mainly on the side to which the occiput points but should change often. The rectum and bladder are to be kept empty.

Spasmodic dilatation of the cervix may be due to primary inertia of the uterus or to abnormal action of the uterine muscle e.g. the formation of contracture rings and stricture. The must be differentiated. The treatment of course varies. In the first we will stimulate in the other tranquillize the uterus. Early in the first stage a dose of castor oil with 3 to 5 grains of quinine may be given. The nasal application of pituitary extract according to Hofbauer's method may be tried but the accoucheur must stand ready to remove the packing and give ether at once when the pains get too strong and endanger the mother or child. I should mention this remedy. Narcotics are the last resort for stricture when they may be aided by atropin in physiological dose.

In the olden time we obtained much benefit from the following procedure: the parturient was given a hot bath (now superseded by a hot wet pack), then a generous alcohol rub, then an enema of 30 grains of bromide of soda and 15 grains of chloral, then a drink of hot lemonade finally 6 to 4 grain of morphine, the room was darkened and quieted. A refreshing sleep lasting 6 to 10 hours usually resulted and dilatation as the result of insensible labor was often found nearly complete when the pains began again.

Should medical treatment fail the dilatation of the os can be hastened by packing the cervix and vaginal vault with gauze saturated in glycerine to which 1 per cent mercurochrome has been added or by metrecruris.

Let us say that the parturient has been carried to the point where the cervix is completely dilated or to a diameter of 8 or 9 centimeters and by means of Dührssen's incisions the opening can be safely enlarged to permit extraction of the child. Now what to do?

First one must be convinced from the character of the labor up to this point that the woman will not be able to end the process herself. It is well to be prepared for surprises as occasionally the head

flexes the pains strengthen and rotation of the occiput to the front takes place rapidly. If the patient merely changes her position in bed or gets up to go to the toilet this favorable mechanism may be started.

Beyond question it is better for the mother and safer for the baby to have anterior rotation of the occiput take place and the birth occur with the usual anterior mechanism. This statement is made though I am well aware that a certain percentage of cases of occiput posterior terminate as such spontaneously with the small fontanel coming out over the perineum and also that a certain number of accoucheurs do not believe in effecting anterior rotation before they attempt delivery. Only when our attempts to correct the abnormal position fail do we consent to deliver the occiput over (usually through) the perineum.

The methods of dealing with persistent occiput posterior positions are numerous. Hodge's maneuver consisting of upward pressure on the symphysis during the pains. Tarnier's maneuver the attempted rotation of the head with the fingers which obtain a purchase behind the ear the same aided by backward pressure on the cephalic prominence above the pubis (the forehead) rotation of the head in the pelvis by combined manipulation under an anesthetic the whole hand being used internally the pushing of the head up out of the pelvis and the rotation of the whole fetal body by twisting the child's trunk to the opposite oblique podalic version the use of the forceps as a rotator or as combined rotator and deliverer.

In the majority of cases it is possible to turn the head in the pelvis by means of the hands at least so far as to bring the small fontanel from the hollow of the sacrum O 180 degrees into an anterior quadrant of the pelvis O L 45 degrees or O D 45 degrees. Then one can easily finish the rotation and the delivery with forceps.

With the patient under deep anesthesia the whole hand is inserted and the head is gently lifted up out of its imbedment in the soft parts. It makes little difference which hand is used inside the pelvis though in O L P I usually put the left hand in behind the pubis and press backward on the forehead lying there with the fingers or if it seems easier I twist the wrist so as to insinuate the fingers underneath and behind the occiput lying on the left side the thumb pressing on the side of the forehead. By the supinating of the hand the head is turned into the transverse. Now the fingers are quickly withdrawn part way the hand reversed so as to bring its dorsum behind the pubis the fingers resting on the malar bone

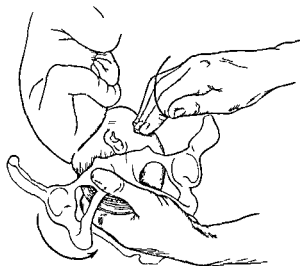
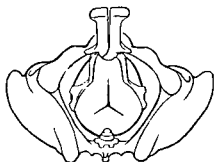


Fig. 1. Changing a right occiput to an anterior position by combined manipulation.

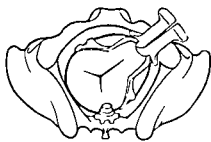
and by a supinating movement pressure on the forehead is exerted sweeping this part of the head through the right half of the pelvis toward the sacrum. Thus the occiput comes to lie near the pubis. This maneuver succeeds best when the head is partly deflexed. When flexion is well established it may be (it is not always) better to work on the occiput directly.

In O L P (O L 135 degrees) with flexion the right hand is laid behind the head with the volar side of the fingers upward and by a pronating twist of the wrist combined with flexion of the fingers the occiput is levered to the front. All the movements are aided abetted modified and controlled by the outside hand and the turning of the head is made easier by lubricating it and the vagina with green soap (Fig. 1). It is also advisable to have the head of the patient 3 or 4 inches lower than the pelvis in order to prevent prolapse of the cord when the fetal head is raised up.

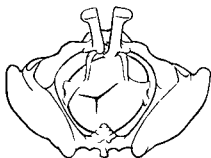
One is often disappointed to find that after the head has been turned into an anterior sector of the pelvic circle before the forceps can be applied indeed often before one withdraws the hand the occiput slips back into its former malposition. There are several ways of handling such a situation (1) have the assistant by a hand above the pubis press the forehead backward and hold it while you apply the forceps (not very successful) (2) have him try to turn the baby's back anteriorly or indeed a little beyond the midline and press down on the fundus to favor flexion etc (also not very successful) (3) the operator can after turning the head as far as it will go withdraw his hand and neatly slip in the other one behind the pubis to press the forehead back (4) he may



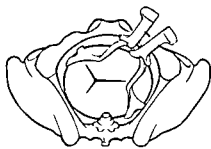
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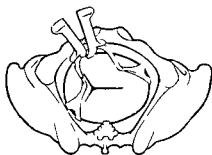
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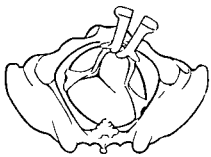
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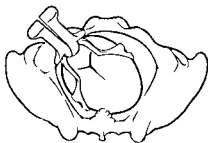
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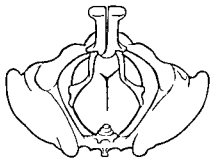
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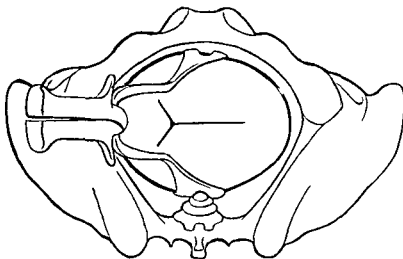


FIG. 3. Forceps applied to the head ODT (Occiput de rees) with the blades in the anteroposterior diameter of the pelvis. The head is grasped ideally but there is danger to the mother's soft parts.

use the hand which effected the rotation internally to hold the head at the point of rotation gained until one blade of the forceps can be applied and thus acting like an old-fashioned vectis will keep the head in its new position or indeed may increase the rotation. (5) he may fix the head at the furthest anterior point of rotation by means of a vulsellum attached to the baby's scalp. He should be sure not to try to turn the head with this instrument; it will tear out a piece of skin—merely hold the head steady with it—thus employed no harm will result.

Should manual rotation fail, which very seldom happens if one goes about it *lege artis*, resource must be had to the forceps. Let me repeat: this article deals with the abnormal position *after* engagement. Before the head has sunk below the inlet version is usually the choice. The operation of forceps in persistent occiput posterior positions may be very easy and very hard. Much depends on individual skill and considerable also upon the conformation of the pelvis and soft parts and the size of the baby and pelvis.

At the very outset of the discussion of forceps in occiput posterior positions we meet this question: May the forceps be used as a rotator or is it to be simply a tractor adding to the downward movement of the head only that amount of rotation which nature gives the head in its passage its progress being thus made a turbinal motion?

Levet in 1746 said that the forceps should be a tractor and nothing else to supply from below the force that was lacking from above. Smellie in 1753 used his short straight forceps as a rotator. Scanzoni in 1865 developed an operation in which instrumental rotation was the main

feature. Tarnier in 1881 demonstrated the principle on which the forceps may be used to correct the position of the head in the pelvis. He pointed out that because of the pelvic curve of the instrument if one twists the handles the blades with the head in their grasp do not turn on the axis of the shanks but tend to describe part of a circle within the pelvis. In order therefore to make the head rotate around an axis it is necessary to sweep the handles of the forceps through a large circle outside the pelvis. The apex of the forceps blades then will act as a center and the head will turn around on it. Bill has improved on Tarnier's maneuver by first raising the head out of the pelvic floor gutter and then sweeping the handles around to impart the movement of rotation to the head within the pelvis. Kjelland in 1915 devised a forceps without pelvic curve and with the blades bent a little downward. With this instrument a head may be grasped biparietally no matter in which diameter it lies in the pelvis and it may according to Kjelland be twisted safely to any position desired.

The dangers of using the forceps as a pure rotator as Scanzoni and Tarnier did are the vagina and bladder may be torn from their attachments to the fascia and the bony pelvis. Hematomata may be produced in the areolar tissue at the bases of the broad ligaments; the ureters may be stretched and the baby's head and neck may suffer damage. If the head is pushed up too far the cord may prolapse necessitating a hurried forceful and destructive extraction. With these things in mind I have devised a method of rotation of the head which combines several of these well-known maneuvers and for want of a



better term I have named it the key in lock operation. It really tries to imitate nature's process of push twist retract untwist and repeat but we have to do them in reverse—push up twist pull and repeat. We try to impress a wriggling motion on the head which is not easy to describe.

With the head lying in the right oblique diameter O D 135 degrees the forceps blades are laid in the transverse of the pelvis. They will grasp the head diagonally in an unfavorable manner and are therefore to be held very delicately. Now under the slightest possible compression the head is pushed up about centimeters in the axis of the birth canal and gently twisted the small fontanel being brought forward not more than 5 degrees. This is done by sweeping the handles of the forceps through an arc of about 10 degrees outside the pelvis *à la méthode Tarnier*. Then the head is pulled down a little in the axis of the pelvis but less than was pushed up. Repeat this maneuver two or three times pushing the head up only as much as you pull down and when the sagittal suture is transverse i. e. O D T or O D 90 degrees the front of the forceps will now point to the left and they will lie in the left oblique. Readjust them so that they will come to lie in the right oblique grasping the head in a more favorable diameter that is the ideal manner. Indeed sometime the head slips around the rest of the way itself within the blades. By pushing up a little twisting a little and levering a very little (to overcome synclitism) imparting a wriggling motion to the head not unlike fitting a key into a stubborn lock one can usually carry the occiput to the front where upon the rest of the operation—the extraction is completed without trouble. One should not hurry nor do too much turning at once not more than 5 degrees it is like taking mincing steps. I readjust the forceps *pari passum* as the rotation is effected (Fig. 2 A to H).

The prehension of the head at the beginning of this operation need not always be made as described. Variants must be recognized but the principle does not change. Sometimes it is possible to lay the blade to the head anteroposteriorly in the pelvis with their front directed toward the small fontanel (Fig. 3). Again one may apply the forceps with the front toward the fore-

head (as in the Scanzoni maneuver) and when the occiput is brought into the anterior quadrant of the pelvis remove them and reapply as for an anterior position.

In rare cases it is impossible to turn the occiput to the front either by manual effort or by the forceps or by a combination of the hands with the forceps. To force the issue would entail great damage to the mother and probably kill the baby therefore we must observe and discover the mechanism intended by nature and then aid it. If the occipitosacral mechanism is inevitable it is best to deliver the head in extreme flexion.

The application of the blades is made as usual but the front of the forceps looks toward the forehead which from now on becomes the point of direction. Locking the blades is the same as usual but after they are locked the handles are raised a little toward the pubis in order to increase flexion. Traction is made on the parietal bosses a little upward from the horizontal plane. This increases flexion and it has happened though I have never observed it that even as late as this anterior rotation has occurred. The occiput is first delivered over the perineum the forehead rests behind the pubis then the brow and face come from under the pubis. Much power is often necessary and it is advisable to perform episiotomy in primiparæ as a rule and almost always in multiparæ to avoid extensive lacerations of the pelvic floor and phincter. If conditions are favorable one might flex the head and deliver as a face presentation. These cases are claimed by the Kielland forceps enthusiasts. Some accoucheurs prefer the axis traction forceps since the mobility they confer on the head allows the latter to adapt itself somewhat to the parturient passage but for the man who knows the mechanism of labor and is willing to be guided by the action of the natural powers they are unnecessary and in the hand of a man ignorant of the principles of obstetrics the instrument is too dangerous.

In cases in which great difficulty is experienced an overlooked funnel pelvis will often be found and the accoucheur will regret that he attempted delivery from below. Here again one should emphasize the necessity of careful antenatal examination and prepartal decision as to the method of conduct in the approaching labor.

## FROM THE CLINIC OF WILLIAM PAPA BLAIR

## SWITCHING OF VERMILION-BORDERED LIP FLAPS

BY J. B. BROWN, M.D., ST. LOUIS, MISSOURI

FOLLOWING are some adaptations of the plan of the switching of vermilion bordered lip flaps for improving balance after removal or loss from either lip. The blood supply through the coronary vessels makes it possible to turn such a flap on an extremely narrow pedicle. This is useful in patients with small lesions on the lip where following a V excision there would be no much difference in the width of the lips if the defect were closed simply by suturing. With the flap available there is not much tendency to cut too close to the growth and because of the simplicity of the technique there cannot be much logical argument against the excision of these growths especially those that have had prolonged and many different kinds of treatment or unknown amounts of radiation. By this method the whole specimen is obtained for microscopic diagnosis without much more trouble than in doing a biopsy (Figs 1 and 2). Accumulated observation has led to the conclusion that all cases of suspected or clinically diagnosed malignancy should have the benefit of microscopic examination of the tissue even if radium or any other destructive agent is to be used. If large sections of the lower lip are removed an upper lip flap may be used in combination with other flaps (Figs 3 and 4). The flaps may be advantageously

utilized on patients with defects following former operations for growths injuries or disfigurement and in some re-operations for cleft lip (Fig 4).

If the defect is near the angle on the lower lip a triangle can be swung directly down from the upper preserving the coronary vessels in a mucous flap. In this instance the pedicle of the flap will form the new angle of the mouth (Figs 1 and 3). The upper lip defect is closed by pulling the lip over to the cheek with any further adjustments necessary to lessen the distortion about the nose and upper part of the lip. The corner of the mouth is put in the best obtainable position but this may be improved if necessary by some subsequent operation (Figs 1C, 3B and C). The suturing should insure contact for the full depth of the wound (Figs 1 and 2).

If the defect is near the middle of the lower lip the remaining lateral portion may be raised as a somewhat rectangular flap and swung across to fill in the center. The defect at the side of the lip can then be filled in with a flap from the upper (Fig 3).

For the swinging of a flap from the lower lip into the upper lip at or near the center the pedicle must of course go across from one lip to the other and remain there until the flap has established its new blood supply. The pedicle is cut

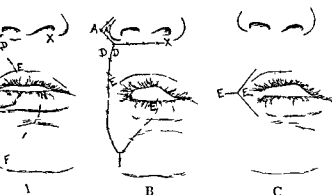


FIG. 1. Plan 1—Large removal from lower lip paired large triangular flap from upper lip that permits immediate adjustment of the remaining part of upper lip to the corner of the mouth the proper vertical level and distal to the nostril. A Shows plan of cuts and excision. B Excised portion of lower lip. C Final triangular flap used for filling in lower lip defect. D A relaxation cut through full thickness of lip. E Final adjustment cuts and the final result. F Immediate adjustment. DE



moved over to the right a dead by relaxation along DA. The line DE in A has been pulled in so that its midpoint occupies a place about where D was before the transfer. E that was at the angle in the upper lip has been swung down around into position near the middle of the lower lip. F forms the new angle of the mouth. Stay sutures through the full thickness of the lip and cheek may be put in across line DE to relieve tension on the blood supply. C Plans of Y cuts for adjustment of the corner of the mouth. The step done at a later time to allow freer opening. Y incision made. DE is pulled back to E and the incision closed in A. D Condition for healing. E is used. F Final result.



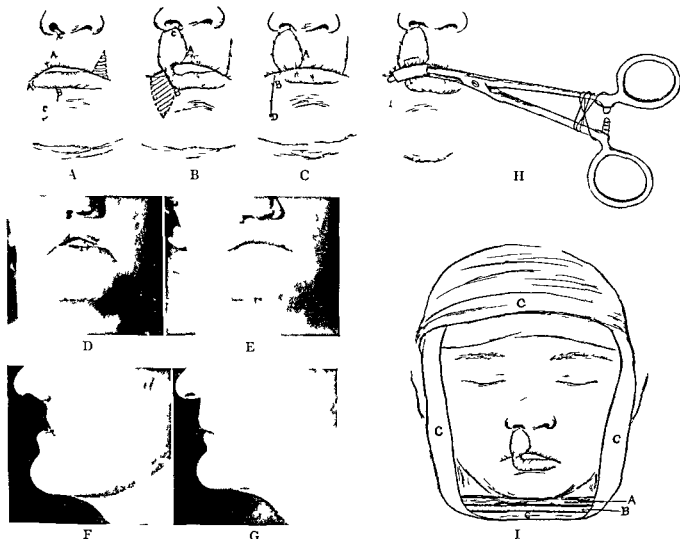


FIG. 4. Plan 4—Used for filling defects of the upper lip at or close to the center. A 1 C Line of opening lip to receive flap. 1 BC flap raised in lower lip. The shaded triangle at the left corner of the upper lip is removed and the defect resutured to correct the deformity shown in D. B Flap ABC in place in upper lip with the pedicle still attached to the lower lip at B through which the blood supply goes. This pedicle is cut in from 2 to 3 weeks after the vitality of the flap is tested by clamping the blood supply through the pedicle. Further adjustment of the union of both lips is necessary but may be delayed for some time after the pedicle is cut if advisable. The defect in the lower lip is left open in this drawing to show the course of the pedicle. C Pedicle of flap has been cut and the vermilion of both lips adjusted. BD Line of closure in

usually between 2 and 3 weeks and before cutting the new blood supply is tested by compressing the pedicle with a rubber covered clamp for an hour or two (Fig 4 H). If after several hours of compression repeated on several consecutive days the color of the flap while the pedicle is compressed remains doubtful it may be well to divide the coronary artery in the flap but postpone the cutting of the rest of the flap until the new circulation is satisfactory. A flap switched

lower lip. D and E Shows a condition for which Plan 4 is used. F and G Same as Figure C and D. H Shows method of gently compressing the pedicle to shut off the vessels through it to the flap. This is to determine the adequacy of the blood supply from the new bed of the flap and it is started about the tenth day. A rubber covered clamp is used and a rubber band is looped over the handles to obtain even elastic pressure. The catches on the clamp are used to hold the rubber band. I Shows method of holding the mouth shut. The head is padded and a plaster cap is put on that holds the plaster sling from the chin. This has been found to be the most comfortable arrangement although a silk worm gut stitch from one lip to the other that does not interfere with the blood supply has been used satisfactorily.

into a scar bed may be slow in gathering its new blood supply. This compression should be gentle to avoid cumulative trauma. A plaster cap with a padded plaster sling down around the chin is the plan used for holding the mouth closed to prevent damage to the pedicle (Fig 4 I).

The area to be excised or to be filled in and the flaps used for repair are to be carefully planned. Accuracy in this point will be evidenced in the result. The blood supply of the flap must be kept

in mind while the flap is being cut as the pedicle consists of but little more than the vermilion border and the coronary vessels. The artery can be felt just under the mucous membrane.

There is seldom much trouble with function although there may occasionally be some leakage of fluids because of lack of sensation or of muscular action. With a little training this can usually be overcome. The patient should put his spoon or cup against the lower lip at the repaired angle and take the food in from there. This same method proves of value to those patients who have lost the inframandibular branch of the seventh nerve from other causes. Most of the patients operated on have satisfactory control of the mouth and

none of them has any leakage of saliva. More accurate data is being collected on the nerve regeneration and muscular action.

In general this plan tends rather satisfactorily to preserve some of the natural prominence and contour of the damaged lip and to prevent the excessive protrusion of its fellow that results from the obliteration of the original defect by the simple approximation of the borders.

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## BRONCHOSCOPIC TREATMENT OF PULMONARY ABSCESS<sup>1</sup>

By HERMAN J. MOERSCH, M.D., ROCHESTER, MINNESOTA  
(Med. M. y. Cl.)

**P**ULMONARY abscess offers one of the most difficult problems in diagnosis and treatment. It has been estimated that approximately 50 per cent of the cases of untreated pulmonary abscess terminate fatally. Miller and Lambert<sup>2</sup> found that the mortality rates in surgery for pulmonary abscess varied between 10 and 60 per cent depending on the operator and number of thoracic operations he had performed.

It is fortunate that bronchoscopy has been of so much value in treating pulmonary abscess and has produced such splendid results. Although applied successfully only in recent years it has already surpassed our greatest expectations and now stands as the most valuable aid in the treatment of this condition.

#### DIAGNOSIS

Before the bronchoscopic treatment of pulmonary abscess and the results obtained are discussed it is necessary to define what is meant by pulmonary abscess. Unfortunately the term is mistakenly applied to many pulmonary conditions. It is easy to understand why these mistakes occur since even the pathologist with the specimen in his hands can not always distinguish accurately between a bronchiectatic condition and pulmonary abscess. A further complication is introduced by the fact that the older an abscess grows the more closely its structure resembles that of bronchiectasis also walled off empyema

may simulate pulmonary abscess and may easily be mistaken for it.

The necessity of distinguishing between pulmonary abscess and other forms of pulmonary suppuration as far as possible is obvious because of the marked difference in their response to medical and surgical treatment. The possibility of relieving pulmonary abscess is far greater than that of relieving other types of pulmonary suppuration especially bronchiectasis. An abscess involves chiefly the parenchyma of the lung—tissues which are elastic and pliable and able to regenerate. After the cavity is drained its walls tend to collapse and healing takes place. Bronchiectasis chiefly involves the bronchi which are rigid tubes and do not collapse when pus is removed but expand in response to extrinsic and intrinsic forces. In time a pulmonary abscess becomes walled off by means of fibrous tissue which forms a rigid wall resembling the structure found in bronchiectasis. It is for this reason that pulmonary abscess of long standing is less amenable to treatment.

Clinically the diagnosis of pulmonary abscess is based on the history which is of the greatest importance, on the physical findings on the roentgenogram and finally on bronchoscopic examination. While errors in diagnosis are relatively easily made in a condition such as pulmonary abscess especially in its differentiation from bronchiectasis still the cases in the group under consideration in this paper have been

<sup>1</sup> Trans. Am. J. M. S. p. 612, 8.

<sup>2</sup> Brit. M. J. p. 121, N. 10, 8, 7.



A

FIG 1 A Pulmonary abscess of 3 months' duration (postpneumonic) B After 4 bronchoscopic aspirations



B

Clinical symptoms disappeared; patient gained 36 pounds and returned to work 4 months after onset of symptoms

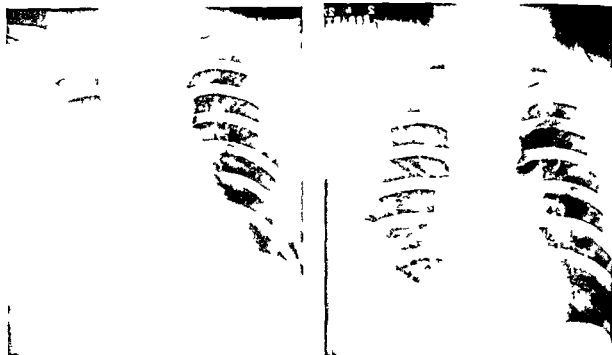


A



B

Fig 2 A Abscess of lung B After 2 bronchoscopic treatments within 5 weeks



F 3 A P t p t i l m i f l y i t B T m th ft b n h p p t

as definitely diagnosed pulmonary abscess as is possible by present diagnostic means

#### TREATMENT

It is extremely important that the bronchoscopist and the thoracic surgeon work in close harmony in cases of pulmonary abscess since complicating factors such as empyema may necessitate operation. The bronchoscopist on the other hand can often give the surgeon valuable information when operation is indicated. It is only through the correlation of bronchoscopy and surgery that the best results can be obtained.

The essential factor in the bronchoscopic treatment of pulmonary abscess is in suppuration elsewhere in the body a sufficient and proper drainage for its removal. In most bronchoscopies regard the lungs as a friable and delicate organ which must be handled with the greatest care. When pus is to be aspirated or an abscess drained the aspirator is introduced through the opening in the abscess very gently and nothing is disturbed. If one considers the trauma to the lung in pulmonary perforations or the ease with which the lungs stand injury when foreign bodies are inhaled such precautions seem unnecessary in treating pulmonary abscess. First of all it is essential that the area of the abscess be definitely

located and this is usually possible from the appearance of pus in the bronchus draining the area involved. At times the site of the abscess is manifested by bulging or obstruction of the lumen of a bronchus due to inflammatory swelling. When the affected area is definitely located an aspirator is introduced into the bronchus from which the pus is exuding or which is obstructed by edema and inflammation. If pus is obtained the aspirator is moved in every possible direction to insure the removal of pus from every accessible pocket. Abscesses may be divided into multiple small pockets and if the aspirator is moved about many of the barriers will be broken down thus insuring better drainage. If the opening into the abscessed area is so small or stenotic as to interfere with the free flow of pus it should be forcibly dilated with a heavy pair of dilating forceps. If necrotic or fibrous tissue obstructs the opening it should be removed with biting forceps. If the abscess is caused by a foreign body the offending material as well as any calcareous deposits that may have formed must be completely removed if the best results are to be obtained.

When the abscess does not drain into a bronchus but bulges into a bronchus one should not hesitate to introduce an aspirator directly into the



Fig. 4. A Pulmonary abscess of left upper lobe of indeterminate origin. B Two weeks later after one

bronchoscopic aspiration. Iodized oil (40 per cent) injected previous to bronchoscopy can still be seen.

abscess. I have never noted any ill effect from such a procedure. It is not advisable to probe into the pulmonary tissue through the bronchial wall in the hope of encountering the abscess; however, if one can be absolutely certain of the site of the abscess, he is justified in burrowing through normal lung tissue to reach it. Some bronchoscopists have feared that fatal hemorrhage might result from this procedure. However, I have found that although bleeding may occur, it is not severe. Blood vessels are undoubtedly torn, but because of the size and shape of the instruments used, they are more than likely torn completely across rather than partially torn. The ruptured end of a vessel torn completely across retracts and contracts more thoroughly; this is of prime importance in the control of hemorrhage.

#### REVIEW OF CASES

During 1925 and 1926, 19 cases of diagnosed pulmonary abscess were treated bronchoscopically with the following results. In 16 excellent results were obtained from bronchoscopic drainage. In 1 case the result was indeterminate and the patient is still under observation. In 1 case operation was resorted to as the results from bronchoscopy

were unsatisfactory. Death occurred in the case of a man whose symptoms had persisted for 1 year and were of indeterminate origin. He improved markedly after 2 bronchoscopic drainages and was permitted to return home. Four months later he died, but I have been unable to obtain information as to the cause of death. In the absence of definite information, I have attributed his death to the pulmonary trouble. Therefore, in the group under consideration, satisfactory results were obtained in 84 per cent. It is my belief, however, that with increased knowledge and improved bronchoscopic technique, this percentage will be increased.

The causes of pulmonary abscess in the 19 cases under consideration were as follows: pneumonia in 4, inhaled foreign body in 3, aspiration at tonsillectomy in 2, aspiration at dental extraction in 1, aspiration during other operations in 3, influenza in 1, secondary to aspiration in cardiospasm in 1, and some indeterminate cause in 3. The etiological factor seems to play an indefinite role in determining the prognosis in all of these cases.

The length of time that the abscess has existed is important in the prognosis. The duration of the disease in this group varied from 20 days to 6





ns definitely drain a pulmonary abscess as is possible by present diagnostic means

#### TREATMENT

It is extremely important that the bronchoscopist and the thoracic surgeon work in close harmony in cases of pulmonary abscess since complicating factor such as empyema may necessitate operation. The bronchoscopist on the other hand can often give the surgeon valuable information when operation is indicated. It is only through the correlation of bronchoscopy and surgery that the best results can be obtained.

The essential factor in the bronchoscopic treatment of pulmonary abscess is in suppuration elsewhere in the lung is sufficient and proper drainage. For one reason most bronchoscopists regard the lung as a friable and delicate organ which must be handled with the greatest care. When pus is to be aspirated or an abscess drained the aspirator is introduced through the opening in the abscess very gently and nothing is disturbed. If one considers the trauma to the lung in pulmonary operations or the ease with which the lung sustains injury when foreign bodies are inhaled such precautions seem unnecessary in treating pulmonary abscess. First of all it is essential that the area of the abscess be definitely

located and this is usually possible from the appearance of pus in the bronchus draining the area involved. At times the site of the abscess is manifested by bulging or obstruction of the lumen of a bronchus due to inflammatory swelling. When the affected area is definitely located an aspirator is introduced into the bronchus from which the pus is exuding or which is obstructed by edema and inflammation. If pus is obtained the aspirator is moved in every possible direction to insure the removal of pus from every accessible pocket. Abscesses may be divided into multiple small pockets and if the aspirator is moved about many of the barriers will be broken down thus insuring better drainage. If the opening into the abscessed area is so small or stenotic as to interfere with the free flow of pus it should be forcibly dilated with a heavy pair of dilating forceps. If necrotic or fibrous tissue obstructs the opening it should be removed with biting forceps. If the abscess is caused by a foreign body the offending material as well as any calcareous deposits that may have formed must be completely removed if the best results are to be obtained.

When the abscess does not drain into a bronchus but bulges into a bronchus one should not hesitate to introduce an aspirator directly into the

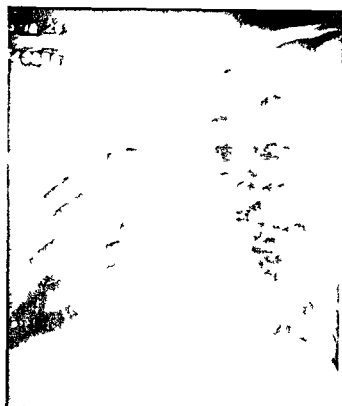


FIG. 4. A. Pulmonary abscess of left upper lobe of indeterminate origin. B. Two weeks later after one

bronchoscopic aspiration. Iodized oil 40 per cent injected previous to bronchoscopy and till before

abscess. I have never noted any ill effect from such a procedure. It is not advisable to probe into the pulmonary tissue through the bronchial wall in the hope of encountering the abscess, however, if one can be absolutely certain of the site of the abscess, he is justified in burrowing through normal lung tissue to reach it. Some bronchoscopists have feared that fatal hemorrhage might result from this procedure. However, I have found that although bleeding may occur, it is not severe. Blood vessels are undoubtedly torn, but because of the size and shape of the instruments used, they are more than likely torn completely across rather than partially torn. The ruptured end of a vessel torn completely across retracts and contracts more thoroughly; this is of prime importance in the control of hemorrhage.

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The length of time that the abscess has existed is important in the prognosis. The duration of the disease in this group varied from 20 days to 6

years When the abscess had been present for 1 month or less excellent results were obtained from bronchoscopic drainage this was also true of cases in which the symptoms had been present less than 3 months Although abscesses of longer duration as a rule responded less rapidly to treatment this was not invariable as the abscess which had been present 6 years was cured by 1 bronchoscopic treatment

The number of bronchoscopic treatments necessary in these cases varies considerably In 12 cases only a single bronchoscopic treatment was required in cases 4 were required The number of treatments depends on the efficacy of drainage There are many factors that must be considered before too definite conclusions are drawn concerning any particular procedure in the treatment of pulmonary abscess Abscesses occasionally drain or rupture spontaneously with complete relief of symptoms although this is rare in those of long standing In my experience

abscess of the right lung has been easier to treat than that of the left chiefly because of mechanical factors The age of the patient has little influence on response to treatment In the present series the ages varied from 2 to 74 years

The illustrations demonstrate as well as roentgenograms can the results obtained by the bronchoscopic treatment of pulmonary abscess Because of pleural thickening it is difficult to obtain as accurate a conception of the improvement as from examination and clinical data

#### CONCLUSION

- 1 Bronchoscopy is of paramount importance in the treatment of pulmonary abscess
- 2 Remarkable results are obtained with little risk
- 3 Time and expense consumed in treatment are reduced to the minimum
- 4 Adequate and proper drainage is essential to success

### THE THERAPEUTIC VALUE OF LIPIODOL IN EMPYEMA

By J LOUIS RANSOHOFF M D F A C S AND JOSEPH D HIRMAN M D CL CLIN TI OHIO  
F m h S I D tm J h i p al

**D**URING the past 3 years we have treated acute empyema by closed intercostal aspiration drainage followed by 2 hourly instillations of Carrel-Dakin solution These instillations are continued until all symptoms have subsided and the bacterial count of the secretion from the fistula is reduced to or 3 bacteria per field The tube is then removed and the wound allowed to close Though this method has in the main yielded satisfactory results there has been a small percentage of cases in which this treatment was inadequate In a few instances subsequent rib resection with open drainage has been necessary This in a measure constitutes therapeutic failure as it results in long hospitalization deformity and possibly chronic empyema

In January 1917 we began using injections of lipiodol to determine the size of the residual cavity before removing the tube It at once became evident that cases handled in this manner had an unusually uneventful recovery In no case in which lipiodol was injected was it necessary to re-institute drainage or irrigations The wounds were dressed and soon healed completely

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p t l M ch 4 9 7 w th th d g soft f l b p

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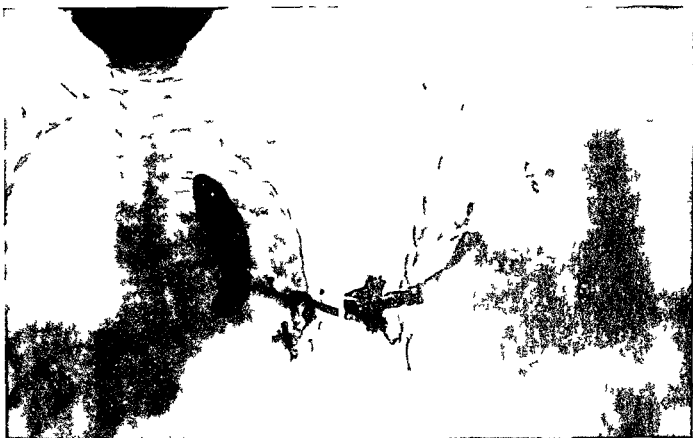


Fig 1 Case 1

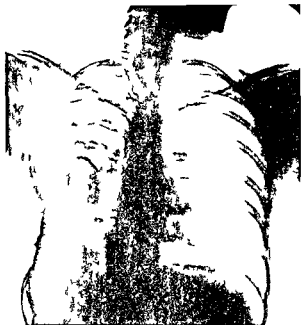
Fig 2 Case



Fig 3 Case 3



Fig 4 Case 4



F S C 5

tl lmp d f l v ft h h t m d O  
M h 3 h d h g d th th d h l d tem  
p t h b m l f w k  
C 3 J f m l g d f d m t t d  
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p m J th l t c t 3 000 O  
J p t n l g t m d f l l d by t f l  
t f C l D k g t 5 m sh d g am  
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Th w l w g d f f Le y t t d  
b t o o d 6 o o X y m t f th  
h t l d h t p l f f o A f t g t f  
t t d p h l p h l t h g l l g d d f l d t f i l l  
S t m h d d m d l g t e t m l  
O t l b l d f m d t t l O M y 7 b o t  
o o t m t f d k m b l d f l d  
l g h t t d t b l d e m d b y p t n  
f m th ch t G m g t b l w f d t h  
f l d t t th g h t p b b l t h t h f  
d y t p b b l m t t c m f t h l n g  
O M y 6 b t m t f f l d f t h m  
b t w m d b y p t D g l l t h  
t m th p t t h d m k d g t t t l y m p t o m  
p t h b d m d f q e t o m t g O J e 4  
p t l d t h k m y p s t g g m  
g t b l l O J 6 p a t d l l r y l Th  
th g h t t r p th p t r l l r y l Th  
w f l l d b y i n t l t f C l D k l t o  
h h t d t l f 7 w h n l p d l j c t i  
m d t n X y p t e t l e w h h w d a  
l g i g l t y l t d p t l y t d f o m  
th f t h t h t h b (F 4) Th t b w s clamp d

ff m ed after 2 days d the w und llo d t cl se  
C le c n c wa terr p t d Th pat t a d s  
h a g d J l y 4  
C se 5 L C fem le g d 3 y s w s adm t t e t  
th J w h H p t l D c e m b r 9 9 6 D a  
ch empy m f t h g h t s d Th h d b p s e t  
f 4 y g l l y f o l l n a t t c k o f p m  
Sh h d h d 4 p e r a t e d e a t c l t h f t l  
T l p t t w w l l d l o p e d a d o n h d n d a d e  
f m t h f t l t h n t l l r y l f t h e t h b  
th o t h g t o t h y h e p h y l e m t  
l j t f s l e l t s h o w d t h t h i t y h l d  
l t 3 o l b w i t e d t o t h c t y  
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d g s k m e d d c t  
f t h t h b m d W i d s f t h f t h d  
i f t h b e t h s e c t d Th t c t w t h p o b e d  
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f o d t c f 7 8 h b e h d t h e t m A t  
m p b l e w t h t c t o f t h u m t l a y t h  
t y d p t w s l a b d t h g r t e s t p b l  
d m t b y t p p t h t r f c f t h e l n g f m  
t h t h t a l l Th t w d w p k d t h  
l f m g a O l D m b 3 t h p l n g w  
m d f C l D k t i l l t o w b g Th  
t d t l l b r y 8 w h l p d l w  
t l l e d a d X y p c t t k w h h d l g  
f t l p p t d g p d d f d c m  
m t g t h a t y l t d b t w e n t h e s c d d  
f t h b t l y d b o u t l h f m t h t  
h t l l (Fg 5) Th t u l l a t o o f l p o d o l a s r p t d  
th n d d t h d d y Th w d a d s e d  
t h t b s i t g t o a d t h p t t s c h d  
4 d y s l t t h t r u c t t d h w o d d l y  
T l w k l t t h w d w a c m p l t y h l d

When it is determined that the bacterial count is reduced to satisfactory limits a sufficient amount of lipiodol is instilled through the catheter to fill the cavity. An X ray picture is taken the catheter clamped so as to retain as much as possible of the lipiodol in the cavity. As was shown in Case 2 the lipiodol instillations may be repeated with advantage. After days the tube is removed and a simple dressing placed on the wound. No subsequent irrigations should be made. These results are interesting in the face of Archibald's article in which he disclaims any therapeutic or bacteriological properties of lipiodol.

#### CONCLUSIONS

In the 5 cases which have been reported 4 were acute and 1 chronic. All healed rapidly after injection of lipiodol. The chronic case is of particular interest since it was especially obstinate and a large cavity extended upward under the sternum and could not be satisfactorily exposed.

The injection of lipiodol into the residual cavity after treatment of empyema by aspiration drainage and Carrel Dakin instillations seems to have a decided beneficial action. It is simple, free from danger, and should be given a trial.

ANGIOMA OF THE KIDNEY<sup>1</sup>

By E STARR JUDD M.D. F.A.C.S. AND HAROLD F. SIMON M.D. ROCHESTER, MINNESOTA  
D. I. S. R. M. J. C.

**A**NGIOMA is the rarest of benign tumors of the kidney. Some observers have even doubted its existence and have ascribed the localized areas of extreme vascularity which occur in the kidney to congenital malformation, localized ectasia or trauma of the renal parenchyma. Cases have been reported however in which it is difficult to explain the observations on any basis other than that of true tumor formation. Whether these lesions are congenital or acquired remains problematic.

## LITERATURE

The literature pertaining to renal angioma is limited almost entirely to case reports; we have been able to collect 11 which seem to be authentic (Table 1).

Virchow mentioned angioma of the kidney and believed that it occurred rather commonly, only less so than angioma of the liver. He reported angiomata of the kidney in conjunction with similar tumors in the liver.

Lutz reported the case of a man aged 6 years who for 5 weeks had suffered from hæmaturia originating in the right kidney. The kidney contained a tumor a little larger than a cherry stone situated at the intersection of the medulla and the pelvis. It was a spongy growth with great endothelium lined spaces, some of them filled with blood. Lutz also referred to several

cases which had been reported in the literature.

Stuedi reported the case of a man aged 9 years. Hæmaturia originating in the right kidney had been present for 0½ years. Decapsulation was without effect and later the kidney was removed. It contained an area in the tip of a papilla composed of typical angiomatous tissue.

Swan reported a case from personal observation and referred to several cases in the literature.

## REPORT OF A CASE

The patient was a woman aged 57 years. For 5 years there had been attacks of hæmaturia occurring every 4 or 5 years and lasting from 2 to 3 weeks. They were sometimes associated with left sided anal colic. The bleeding was at times so severe that the patient became weak and lost weight but she always recovered rapidly after the bleeding ceased.

On examination she appeared healthy. Neither kidney was palpable. Cystoscopic examination demonstrated that there was less cretation from the left kidney than from the right. The left pyelogram was normal.

In view of the history of repeated anal hæmorrhage, often of alarming degree, associated with pain which was always referred to the left side, and of the reduced function of the left kidney, it was thought advisable to explore the left kidney. At operation the superior pole was found to be occupied by many dilated blood vessels and nephrectomy was performed. Convalescence was uneventful and 3 months later the patient was perfectly well.

The kidney was small. The capsule was stripped off easily and the surface of the kidney was granular. The tumor was situated in the cortex and occupied the upper pole. It measured 5 by 5 centimeters and its outline



Fig. 1. Angioma of the kidney. The endothelium lined spaces filled with blood are shown. (X 100)



Fig. 2. Tiny carcinoma of the kidney. The blood filled spaces are lined with epithelium. (X 50)



years. In 7 cases the sex was mentioned 5 were males and 2 females. In 5 of 7 cases in which the situation was mentioned the tumor was in the left kidney and in 2 in the right.

In the cases described in the literature the microscopic structure has consisted of either large cavernous sinuses lined with endothelium or thick walled vessels more or less dilated and filled with blood. Thrombosis has been observed within these vascular channels and in several instances deposits of calcium salts. Surrounding the vascular channels there may be round cell infiltration and deposits of pigment.

A distinction must be made between true angioma and other blood containing tumors which may occur in the kidney. Carcinoma in which the spaces and cavities have become packed with blood cells (Fig. 2) is most likely to lead to confusion. Such a tumor may be distinguished by the type of epithelium lining the blood filled spaces and a close examination of different portions of the tumor will usually disclose areas in which hæmorrhage has not occurred. Hæmorrhagic cysts of the kidney will not be confused with angiomas if one remembers that angiomas are practically always small while hæmorrhagic cysts are usually quite large. As shown in a previous paper these cysts usually represent an occluded aneurism and consist of a single cavity while angiomas are composed of multiple cavities. Begg reported a case in which he found angiomatous tissue in the periphery of a hæmorrhagic cyst which he believed was responsible for

formation of the cyst. Trauma may result in the escape of blood within the interstitial spaces of the kidney but obviously here again the microscopic picture serves to distinguish this extravasation from angioma.

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PYLORO-DUODENOSTOMY FOR DUODENAL ULCER<sup>1</sup>

By CLYDE A. ROFDER, M.D., F.A.C.S., Omaha, Nebraska  
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In presenting a new operation for peptic ulcer of the stomach or duodenum one must keep in mind that all lesions in these areas which require surgical therapy depend more upon the operation of gastrojejunostomy than upon any other operative procedure and that without this operation surgery of the stomach would never have occupied the useful position that it does today. In those instances wherein the anastomosis does not function properly it can be undone a situation which can never arise with more radical forms of unsuccessful gastric surgery. When there is a more or less complete and permanent obstruction in the stomach or duodenum gastrojejunostomy thereafter drains all of the gastric contents. When an ulcer is present without complete obstruction the greater portion of the gastric contents soon after the operation pass back through normal channels via the pylorus and duodenum. Under these conditions the spastic obstruction in the ulcerated area is relieved and held inactive by the anastomosis which prevents an accumulation in the stomach of gastric secretions sufficient to produce an irritation with its resultant spasm in the ulcer area.

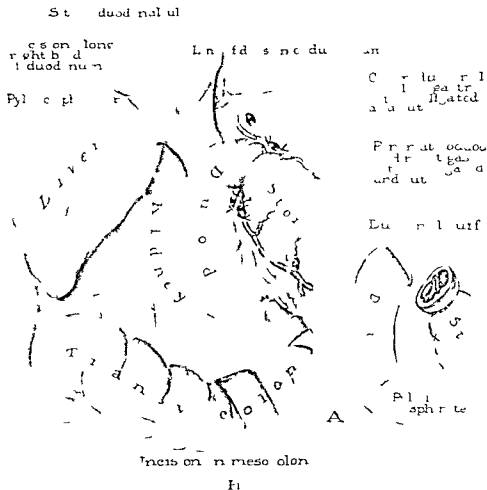
For the successful functioning of this operation the essentials are a proper incision and a proper technique which will bring about a complete drainage of the proximal loop and sufficient drainage of the stomach. The greatest barriers are reflex disturbances of the gastric secretion and incomplete drainage of the proximal loop and stomach contents. When a gastrojejunostomy is properly performed upon a patient troubled with a stomach syndrome resembling that of a gastric or duodenal ulcer but due to a gastric reflex the anastomosis merely adds to the distress of the patient. However it is not the peptic ulcer with or without organic obstruction which makes this operation successful. Its success depends in the presence of a proper technique upon an absence of reflex gastric spasms and a postoperative anatomical position of the anastomosis wherein the jejunal loops are completely and the stomach sufficiently drained. Gastrojejunostomies should produce no more distress in persons with perfectly normal stomachs and duodenums than in those with peptic ulcers with or without organic obstructions. It seems rational therefore to assume that the primary pathological condition has nothing

to do with the functioning of this operation because it functions as well remotely after the operation when the stomach or duodenum has been restored to normal or as near normal as possible.

There is a small percentage of patients in whom the most popular gastrojejunostomy in the hands of many surgeons will not function without distress perhaps because of an unavoidable postoperative position of the anastomosis which interferes with proximal loop drainage. Balfour and Moynihan well state that with the enormous number of gastrojejunostomies performed there are bound to be a small number unsuccessful which gives undue publicity to this one of the most useful of all surgical procedures. It is an operation which has destroyed or removed nothing having merely added a new function which cannot as with all forms of therapy be expected to be successful to a degree approximating a percentage of 100.

The number of patients in whom a gastrojejunostomy will not function satisfactorily because of insufficient drainage of the stomach and jejunal loops is large enough however to demand attention. There are few operations which leave the average surgeon with more anxiety relative to immediate and remote postoperative obstruction owing to the fact that the postoperative position and condition of the anastomosis and the amount of obstructive peritoneal adhesions surrounding it can not always be foreseen. This inability to obtain perfectly successful gastrojejunostomies in all patients together with the occasional second or third gastrojejunostomy has led to the adoption of numerous modifications and new surgical procedures.

The operation I am describing here is brought forth with the idea that it is not a substitute in the majority of instances for the properly indicated and properly performed gastrojejunostomy for duodenal ulcer. I feel that it has a place following in undoing of an unsuccessful gastrojejunostomy and also in some instances wherein it may function satisfactorily without the help of a gastrojejunostomy. Another qualification is that it simulates the normal more than any other operation is yet proposed and if it is unsuccessful it can be helped by the addition of a gastrojejunostomy.



## TECHNIQUE

Six years ago shortly before Haberer<sup>1</sup> described his anastomosis of the resected stomach to the duodenum I began performing the operation herein described. The essential difference between Haberer's operation and mine is that he applies his operation after resection of the distal end of the stomach for gastric ulcers. I apply my operation for ulcers of the duodenum leaving the distal end of the stomach including the pyloric sphincter intact. Haberer's operation is an implantation of the amputated stump of the stomach into the second portion of the duodenum while my operation is a reimplantation of the pyloric sphincter into the second portion of the duodenum.

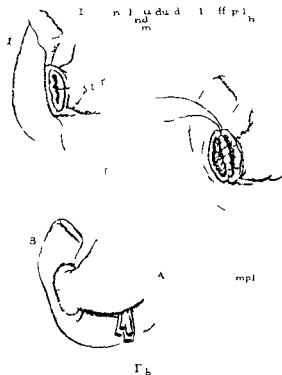
The contra indications to an attempt to perform this operation are too firm congenital and inflammatory fixations of the descending portion of the duodenum and multiple duodenal ulcers which might prevent a permanent closure of the duodenal stump.

The ideal conditions indicating the performance of this operation are a lack of obesity, a

more or less naturally mobile duodenum and a single small duodenal ulcer. The ability of the surgeon as an operator will modify these statements to a certain degree.

Ample mobilization of the duodenum is essential and can be brought about in proper instances by cutting the mesentery of the hepatic flexure and adjacent transverse colon free from the posterior abdominal wall, right kidney, and duodenum. This incision is added to Kocher's which is an incision through the peritoneal reflection of the outer border of the descending duodenum. With this combined method and a careful finger dissection the descending and transverse duodenum up to the superior mesenteric vessels can be mobilized to a surprising degree. Care must be exercised not to destroy the blood supply which comes to the duodenum on its concave surface.

After sufficient mobilization is accomplished the duodenum is amputated through its second centimeter from the pyloric ring and the distal opening carefully closed. The ulcer is inverted as the walls of the duodenum are sewed in and without doubt is destroyed by the resultant healing process brought about by the inverting sutures.



The pylorus with its narrow duodenal cuff is then ready for its anastomosis with the second

portion of the duodenum on its peritoneal surface. Experience has taught me that a transverse incision through the pyloric sphincter prevents a too narrow anastomotic lumen as well as a spastic obstruction. The incision should be carried through the duodenal cuff, pyloric sphincter and about 1 or 2 centimeters of the stomach wall.

Most painstaking, small but deep biting sutures on a sharply curved needle are necessary for the outer row of the anastomosis in order to prevent too much infolding and consequent narrowing of the inner orifice. Traction on the anastomosis may be prevented by attaching the falciform ligament of the liver well up on the first half of the stomach after the method which is used by W. J. Mayo.

#### RESULTS

I have 5 patients now in excellent health and their operations were performed 6, 4, 2, 1 and 1/2 years ago. I have not restudied any of these recoveries with the roentgen ray and gastric analysis because of the difficulty of having the patients return for examination, but letters from them state that they are perfectly well. This small series of patients indicates that this operation has possibilities.

## GASTRO-ÆSOPHAGEAL CARCINOMA ITS DIAGNOSIS

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F m th G t l t t l C l D p t m t f M d R y l t H p t l M t t l

**M**ALIGNANT lesions of the cardia and of the stomach fundus frequently offer great difficulties in diagnosis. This is particularly true of early cases that is before the onset of marked loss of weight, anæmia and cachexia. Unfortunately this triad of symptoms is considered by many physicians absolutely essential for the positive diagnosis of malignancy, a view in a large measure fostered by the unnecessary prominence given these signs in textbooks. Malignancy of the cardia and of the lower œsophagus is so relatively benign and metastases occur so late that successful surgical treatment may be possible provided diagnosis is made sufficiently early.

It is the purpose of this paper to report a survey of the methods used by various clinicians and roentgenologists in establishing early diagnosis to attempt to estimate the relative value of clinical symptoms (objective and subjective) generally considered of cardinal importance and to report two cases which gave rise to considerable difficulty in diagnosis.

## RELATIVE INCIDENCE

In an attempt to determine the relative incidence of carcinoma of the cardia it was found that it is included indiscriminately in the statistics dealing with carcinoma of the stomach and with carcinoma of the œsophagus. Greater precision in this respect is most desirable.

Carcinoma of the fundus and of the cardia is of relatively frequent occurrence. In a series of 50 cases of primary carcinoma of the stomach in the autopsy records of the Peter Bent Brigham Hospital reported by Duggan (5) 8 per cent occurred at the fundus and 12 per cent at the cardia that is in 20 per cent of this series the growth was located in the region of the gastro-œsophageal junction. Spriggs (22) reports 25 cases of gastric carcinoma of which 16 per cent occurred at the cardia. In Welch's analysis of 1,300 cases of malignancy of the stomach 104 (8 per cent) were situated at the cardia and 19 (1½ per cent) at the fundus (12). In Walton's series (25) of 150 cases of gastric carcinoma 60 (40 per cent) occurred at the cardiac end. In Taylor and Miller's series (23) of 182 cases of gastric malignancy in 10 per cent of the cases the tumor growth began at the fundus or cardia. Of 557

cases of carcinoma of the stomach operated on at the Mayo Clinic (1918-1920) reported by Hartman (7) 39 (7 per cent) were found to be at the cardia. Walton (5) quotes Meyer to the effect that carcinoma of the cardia forms 50 per cent of all cases of carcinoma of the œsophagus. Vinson (24) reports 154 cases of œsophageal cancer of which 62 (40 per cent) began at the cardia and secondarily involved the lower œsophagus. Lilienthal (14) states that malignant tumors of the œsophagus are most frequent at the cardia.

## SYMPTOMS

The symptom complex of carcinoma of the lower œsophagus of the cardia or of the fundus is not in each case a clear cut entity varying with the situation of the lesion but is very similar in all three situations. Nor is it sharply distinct from the picture presented by such conditions as cardiospasm, spasm of the œsophagus, carcinoma of other parts of the stomach, etc. It is only by very careful investigation of all cases complaining of suggestive symptoms and a thorough understanding of the difficulties in examination due to the anatomical situation of the lesion and of the pitfalls arising from the limitations of the various methods of diagnosis at our disposal that the number of undiagnosed cases will be reduced to a minimum.

The symptoms of carcinoma of the fundus are very often referred to the œsophagus (Palugury (17) while symptoms of cancer of the cardia are generally gastric in nature (Walton's Surgical Dyspepsias). Frequently carcinoma beginning at the fundus gives rise to symptoms which point to the œsophagus as the offending organ and the associated spasm of some portion of the terminal œsophagus leads even after careful but incomplete examination to a diagnosis of cardiospasm or spasm of the œsophagus. On the other hand the symptoms may suggest a gastric origin and X-ray examination of the stomach may reveal an irregularity of the duodenal cap which in this case is only an expression of the increased irritability of the stomach. In this manner only the associated condition is disclosed and the true disease is overlooked and allowed to go on until cachexia and marked loss of weight make the diagnosis more obvious. One must bear in mind the possibility of a gastric carcinoma in the



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presence of oesophageal symptoms which may be present early and are usually present in advanced cases

#### MODE OF ONSET

Allu (1) states that in every case of gastric carcinoma there is a symptomless latent period of

several months duration and that the initial stage at which the patient becomes aware of the disturbance may be considered the second stage of the disease. Especially is this true of carcinoma of the fundus corpus and of the lesser curvature. Friedenwald (6) divides gastric carcinoma into two groups according to the manner of onset. The onset of symptoms is sudden in a large proportion of cases and is gradual in a



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smaller number in which the cancer has developed from a pre existing ulcer. In his series of 1000 cases of gastric cancer a history of previous digestive trouble was present in only 23 per cent of his patients while the onset was sudden and acute in 77 per cent. Deaver (4) also describes two similar clinical types of gastric cancer one with history of long duration beginning with ulcer symptoms which later change to those of carcinoma and a second group in which the onset is insidious with vague symptoms of indigestion and epigastric distress and is rapidly progressive. Walton (25) maintains that the onset of symptoms of cancer at the cardia is nearly always insidious and the symptoms are generally gastric in nature.

The symptoms of which the patients usually first become aware are inconstant indefinite and often transitory occasionally they are permanent.

Loss of appetite partial or complete is a fairly constant symptom. It was present in 89 per cent of the cases in Friedenwald's series. In 5 cases of cancer of the cardia fundus and lesser curvature near the cardia reported by Soult (21) loss of appetite was present in 4 cases.

Gas eructation is a prominent and early symptom in carcinoma of the cardia (Albu 1; E. I. Spriggs 22). Albu also mentions as early symptoms bitter taste in the mouth regurgitation of small quantities of food or sour liquid a sense of tension in the stomach and rapid satiation.

Dislike of certain articles of food particularly meat is a common symptom. This may at first be inconstant. Nausea is occasionally present.

Dull pain is occasionally present but as indicated severe pain is frequently only a comparatively late symptom. It is usually drawing in character and radiates from the stomach in various directions especially to the back and shoulders. It occurs independently of meals and may vary in the same patient. Albu believes the pain to be due to the drawing of the serosa into the tumor mass or to adhesions with neighboring organs. In Friedenwald's series pain was present in 93 per cent of the cases and as an early symptom in 84 per cent. In carcinoma of the cardia the discomfort or pain may be felt to the right of the epigastrium behind the sternum or in the back (Spriggs). The pain in the epigastrium may go through to the back. It comes on shortly after or even during every meal and is persistent. It differs from pain occurring in carcinoma limited to the œsophagus in that it is present after meals and is not caused by the passage of food through the œsophagus. Very severe pain usually indicates a relatively wide

spread growth and adhesions to the surrounding structures (Walton).

Vomiting is a constant symptom only in cancer of the pyloric region. Regurgitation of actual food is more characteristic of œsophageal cancer.

Hæmatemesis occurred in 22.7 per cent of Friedenwald's series.

Dysphagia may be caused by the direct obstructing effect of the growth if situated at the cardia or when malignancy of the fundus has spread to the lower œsophagus or in either case indirectly by the associated spasm which may be present even before the growth is large enough to cause obstruction. At this stage the picture assumes definite characteristics of œsophageal disease. Dysphagia occurring in a patient over 40 years of age is a symptom of grave importance. In 78 per cent of cases in Friedenwald's series difficulty in swallowing appeared early. In two cases reported by Paluguav the onset of dysphagia was sudden with remissions of short duration. Both cases were associated with spasm which probably explains the sudden onset and intermittent character. A slowly developing dysphagia progressively becoming worse with remissions occurring only at first if at all should raise a strong suspicion of the presence of malignancy of the œsophagus or the region of the gastro-œsophageal junction. An apparent improvement in the condition consisting of a temporary disappearance of the dysphagia in a well developed case should not be misleading. (The degree of dysphagia increases with the progress of the growth until occlusion of the lumen finally occurs. This may be followed by pressure necrosis and disintegration of the central tumor mass with consequent temporary diminution of the dysphagia.) At first occasional dysphagia is brought on by swallowing a large hard and rapidly chewed bolus. Soon even very carefully masticated food is swallowed with difficulty but may be washed down by fluids. Ultimately it becomes impossible to get solids down even with the aid of fluids and finally even fluids cannot pass. There is usually an associated sense of pressure behind the sternum which may be moderate in degree or quite severe. In cancer of the œsophagus it is only very rarely that the onset of dysphagia is sudden and is then probably due to the secondary spasm. In this connection Ridder's observation (20) is of interest. It is very characteristic of carcinoma of the œsophagus that narrowing can be demonstrated either subjectively than objectively by means of the sound. When remissions occur they are usually of short duration.

As the case progresses other symptoms may develop regurgitation cough hiccough and choking sensations

Pehfus (10) quoting Pratt states that excessive salivation is often an early symptom of malignancy of the lower oesophagus Howarth (9) makes a similar observation

Hoarseness and aphonia due to pressure of secondary enlargements upon the recurrent laryngeal nerve are fairly frequent findings Vocal changes occurred in 18 out of 36 cases reported by Sokata (quoted by Lilienthal 14)

Walton mentions lack of strength and early symptoms of carcinoma of the cardia

Lack of appetite gas eructation pain and dysphagia are the only frequent and early symptoms Only the last is suggestive of lesions of the oesophagus cardia or fundus

#### EXAMINATION OF PATHENT

The patient presents a definite picture of malignancy only very late in the disease and it is therefore advisable to omit a description of a so called typical case but rather to discuss the individual signs their relative frequency and importance

Marked malnutrition and cachexia as has already been stated are late manifestations and according to Albu should not constitute an important part in the carcinoma picture In young people cachexia is often entirely absent (Wheeler 6) and in carcinoma of the lower oesophagus marked cachexia is rarely seen (Howarth 9)

Fever is comparatively rare in gastric carcinoma It is intermittent in character lasting weeks or months (Albu) In young individuals fever occurs earlier and is more frequent (Wheeler)

Enlargement of the supraclavicular glands is a comparatively infrequent finding in malignancy of the stomach and when present indicates marked advance of the disease In 1500 cases reported by Albu such enlargement was present in only 12 Walton however reports its occurrence in 3 per cent of gastric cancer cases

#### LABORATORY METHODS

The test meal does not give conclusive evidence for or against the presence of malignancy This is particularly true of carcinoma of the cardia and fundus since gastric retention does not occur in such cases

Achlorhydria does not necessarily indicate malignancy while on the other hand normal acid values and even hyperacidity may be present Horak quoted by Rehfuess states that in 50 per cent of the cases acid is present in the stomach

either in the beginning or constantly Although free hydrochloric acid and later the combined is very often absent in cancer absence of free hydrochloric acid occurs in benign disease of the stomach while its presence does not exclude carcinoma Kuettnr (13) Hurst (10) and others express the same conviction Hartman gives the following figures for 551 cases of gastric carcinoma occurring at the Mayo Clinic during a period of 3 years Ignoring the location of the tumor achlorhydria occurred in 53.72 per cent hypochlorhydria in 15.78 per cent normal values were present in 17.42 per cent and hyperchlorhydria in 4.53 per cent of the cases Normal or hyperacid values were therefore present in 1.95 per cent of all cases in the series while achlorhydria was present in little more than half of the cases Hartman's figures for achlorhydria occur in cases of cancer at the cardiac end are a little higher—61.54 per cent These figures are based on the highest readings obtained during fractional gastric analyses In Ilow's series of 50 cases (15) 17 per cent had normal or hyperacid values in the resting juice and the fractional analyses brought the figures up to 50 per cent Taylor and Miller (3) give the following figures for 182 cases of gastric cancer Acid determinations were done on the 45 minute fraction of the Iwald test meal Achlorhydria was present in 68.4 per cent hyperchlorhydria in 4.5 per cent normal acidity in 14.8 per cent and low acidity in 12.9 per cent of the cases (Normal and hyperacid values in 17.3 per cent) Friedman's series of 1000 cases showed a much higher proportion with achlorhydria (89 per cent) He draws attention to the fact however that there is a natural tendency to a diminution of gastric secretion after the fast meal and that it is not uncommon to observe this condition as a manifestation of old age

There should not therefore be too much stress placed on this finding as evidence of the presence of malignancy Even though achlorhydria is a somewhat frequent finding in carcinoma of the fundus and cardia it is not a sufficiently constant finding to make it a valuable aid in diagnosis According to Albu however the rule in fundus carcinoma is the absence of free hydrochloric acid In marked contrast with this statement stand the figures of Hartman who found free acid present in 38.46 per cent of 39 cases of cancer at the cardiac end of the stomach

Secondary anaemia though frequently present in cancer of the stomach is always a late sign (Albu) It may however be absent even in advanced cases Hurst (10) reports 2 cases of 95 per cent and 103 per cent haemoglobin respectively

In 1 of the 2 cases reported in this paper the blood picture was normal. According to Hirschfeld (8) anemia associated with leucocytosis in the absence of fever or infectious diseases should lead one to suspect malignancy.

Occult blood in the stools is a very constant and early finding. Tarry stools occur much less frequently (in 18.9 per cent of Friedenwald's series). Occasionally occult blood may be temporarily absent from the stool and it is therefore necessary to repeat the test on several occasions.

Thus subjective and objective symptoms as well as laboratory findings are insufficient to establish early diagnosis. Although some of the symptoms enumerated are very frequently present in carcinoma of the region of the gastro-æsoophageal junction their presence does not constitute proof of such a lesion. They should serve however to arouse the suspicions of the clinician and to prompt him to exhaust all methods of examination before declaring that a malignant lesion is not present.

According to Chevalier Jackson (11) there are only two reliable methods of diagnosis in carcinoma of the œsophagus—the X ray and œsophagoscopy. The latter is unfortunately of little value in the diagnosis of cancer of the cardia or fundus even in the presence of extensive invasion.

#### X RAY DIAGNOSIS

From the roentgenologic point of view there are two pathological groups of fundus and cardia cancer: (1) infiltrating flat growths associated with shrinking (scirrhous type) (2) the fungating cauliflower type of growth. The medullary type of tumor which in the rest of the stomach gives rise to a filling defect is seen in the fundus as a tumor shadow jutting into the gas bubble which may divide the barium stream as it enters the stomach. This type of tumor growth gives comparatively little difficulty in diagnosis. It is the flat squamous cell type that is troublesome. To diagnose cancer at the cardia we must depend upon irregularity of the cardia and of the terminal portion of the œsophagus as direct signs.

The main difficulties in the X ray diagnosis of cancer of the fundus and cardia are those caused by (1) the location of the growth. In the case of carcinoma situated at the fundus the lesion may be overlooked (unless it is a medullary one and encroaches upon the gas bubble) because the barium suspension does not fill the fundus in the upright position nor do peristaltic waves ordinarily traverse the upper pole of the stomach. In the ordinary routine positions of examination cancer of the cardia may be overlooked because

the liver shadow hides the subdiaphragmatic portion of the œsophagus (Ridder (5)), and in the horizontal position because the last portion of the œsophagus and with it the cardia are covered by the filled fundus (Palugury (16)). Carcinoma of the fundus as has been previously stated is frequently associated with spasm of the cardia or lower œsophagus and that of the cardia with spasm of the lower œsophagus. These associated spastic manifestations may mask the more serious condition lower down in the gastro-intestinal tract. It is necessary therefore when ordinary methods fail to resort to special methods of X ray examination in suspected cases.

If the barium suspension enters the stomach without being arrested in its downward course or without disclosing some irregularity of the areas under inspection the barium paste should be tried. Very careful screen examination in addition to skiagraphy is essential. The patient is examined in the upright left oblique position to begin with. This position brings into view the œsophagus in the greater part of its course. It is essential to have the patient take single small sips of the opaque meal. Very often a large mouthful of barium suspension is arrested at the cardia while a small quantity will trickle into the stomach without any difficulty. The swallowed barium is followed in its passage through the œsophagus particular attention being paid to the manner of its entry into the stomach. There is frequently partial or complete arrest of barium at the cardia and in the case of fungating tumors of the lesser curvature near the cardia a forking of the barium stream or the presence of a tumor shadow silhouetted against the background of the gas bubble may be present. When complete arrest of barium occurs at the lower end of the œsophagus in spite of taking small quantities at a time spasm of the cardia or of the œsophagus is diagnosed. Absence of marked dilation or tortuosity of the œsophagus will tend to rule out true cardiospasm as opposed to spasm of the cardia or of the œsophagus. Smoothness of the contours of the lower end of the barium filled œsophagus does not rule out malignancy since spasm occurring oral to a lesion may be situated in an entirely normal portion of the œsophagus. Palugury (16) quotes Assman to the effect that in idiopathic dilatation the subdiaphragmatic segment of the œsophagus often lies transversely and is directed to the left, while in carcinoma it follows an almost vertical direction and there does not occur any greater lateral deviation to the left than that usually present. Howarth (9) and Rehfuess (19) find that the



triangular space formed when the œsophagus turns forward and to the left to enter the diaphragm is often of limited malignancy.

If in spite of slow sipping the barium does not enter the stomach and the œsophagus is not found to be markedly dilated or tortuous that is if signs of longstanding obstruction are absent the patient should be re-examined after administration of a larger amount to the limit of tolerance. In the series of Palu (17) it is only when the barium stream through the cardia occurs that a diagnosis of this region can be made and it is difficult to make whether spasm only is present or an organic lesion in addition. Only the fluoroscopic method permits and a normal barium swallow with the cardia mechanism in the spasmic stage permits one to exclude carcinoma of the cardia.

Shrinking of the stomach and its displacement upward and to the left is visible present in carcinoma of the stomach (Carmichael). The inability to swallow the stomach in cancer of the cardia is mentioned by Allu. Both signs were present in one of the cases reported here.

Allegation that gas bubble is an important sign. Infiltration of the cardia may give rise to inefficiency of the cardiac sphincter resulting in escape of the normally filling the fundus. Thus a prominently absent gas bubble is evidence of inefficiency of the cardia and points to the possible presence of infiltration (Bergmann).

If the patient should next be examined in the horizontal position. For proper examination of the fundus it is necessary to have the stomach well filled. Normally the fundus fills the dome of the left diaphragm and lies in close apposition to it. Its upper limit traces a smooth curve. Occasionally this contour is dentate, this appearance probably having the same significance as the dentate appearance of the greater curvature due to contraction of the muscularis mucosae. This irregularity must not be confused with that produced by a local lesion. In such cases the irregularity is not regularly dentate and does not follow the semicircular arch of the fundus. The transverse diameter of the fundus is also much narrower than is usual (due to encroachment of the tumor upon the lumen of the stomach or to shrinkage in scirrhus forms).

If careful examination as outlined above fails to reveal the presence of a lesion the region of the cardia should then be thoroughly examined. The carcinoma is brought into view for careful inspection in ordinary method of examination. The reason for this has already been mentioned. I would advocate the Stuart position. The

stomach is filled with gas and the patient fluoroscoped in an oblique position the rays being directed from the right posteriorly and above to the left anteriorly and below. An unobstructed view of the cardia and terminal œsophagus is obtained in this manner. According to Palu, carcinoma of the cardia can be recognized even in cases showing but little change in the stomach wall but in which the normal cardia mechanism is disturbed. There is a persistent trickling of barium through the cardia and as a rule the outlines of the epigastric meal as it passes through the cardia are seen to be irregular and jagged. It is only however the irregularity of the contrast silhouette in the region of the cardia with the patient in the Trendelenburg position that can be considered as direct X-ray evidence. Pavr-Hohlbaum (18) points out that in cancer of the cardia the upper pole of the stomach is an unusually great distance away from the diaphragm.

The direct signs of gastroesophageal cancer are

- (1) Tumor shadow bulging into gas bubble
- (2) irregularity of the barium contour as it passes through the cardia
- (3) splitting of barium stream on entering stomach

The indirect signs are

- (1) Spasm of the œsophagus or cardia
- (2) displacement of the cardia mechanism (Palu)
- (3) absence of the gas bubble
- (4) shrinking of the stomach
- (5) drawing of stomach upward and to left
- (6) increased distance between the upper pole of the stomach and the diaphragm
- (7) narrowing of the fundus
- (8) obliteration of the triangular space mentioned by Howarth and Hefuss

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ne active. The pulse was 94 regular with good volume and tension. Systolic blood pressure was 155 diastolic pressure was 80. The heart findings were negative. The abdomen was full and soft. No organs or masses were palpable. There was no tenderness. Lymphatic genito urinary and nervous systems were negative. Rectal examination was negative except for hemorrhoids. The urine was essentially negative. The stool showed occult blood on several occasions. The blood wasermann's was negative. In the gastric analysis the tube failed to enter the stomach.

Bougies were passed without difficulty down to 45 centimeters from the teeth. No obstruction was met with until the cardiac end of the esophagus was reached.

Direct esophagography on July 1925 led to a diagnosis of stricture of the esophagus. The pathological report of biopsy specimen taken from the lower end of the esophagus was: There is no definite evidence of inflammatory reaction or of neoplastic proliferation.

A barium swallow. The patient was instructed to swallow barium in small sips. There was some delay at the cardia. The esophagus was only slightly wider than normal. The lower end of the column of barium in the esophagus showed a fine irregularity. Barium entered the stomach in a constant small trickle and was caught in a small irregularity of the gastric wall on the lesser curvature just below the cardia. The retained barium remained there throughout the examination. The stomach was very small and lay entirely to the left of the pinal column. In the horizontal position a walnut sized filling defect was seen on the lesser curvature near the cardia. This defect corresponded with the area of irregularity observed in the upper position.

On the grounds of persistent dysphagia without remissions the presence of blood in the stool and the X-ray findings a diagnosis of carcinoma involving the lesser curvature and esophagus was made. Three months later because of increasing difficulty in taking nourishment the resultant marked emaciation surgical intervention was decided upon. The operation was performed on August 7, 1925.

It was with difficulty that the dome of the diaphragm was reached. There was a suspicious hard nodule around the lesser curvature of the stomach and the celiac axis probably invasion from the lower esophageal groove. The fundus of the stomach was firmly fixed.

A Witzel gastrostomy was done. A snip from the lower end of the esophagus was reported as undoubtedly carcinoma, one from the growth of the lesser curvature was too small for diagnosis.

The patient did well for some time then gradually declined and died on November 26, 1925.

CASE. Mr. S. H. White, 45 years old was first seen on June 1, 1916. He complained of pain behind the lower end of the sternum on eating difficulty in swallowing solids accompanied with pain. Erection of gas associated with pain increased salivation loss of weight and appetite. His illness began years previously. He first complained of a little pain behind the lower end of the sternum with every meal. Frequently only the first swallow brought on pain and the pain disappeared with the taking of additional food. The pain did not radiate. It was relieved by bicarbonate of soda. There were gas eructations but there was no nausea or vomiting. The condition persisted for about 2 months and was followed by a remission of 2 months. During the subsequent 18 months the patient suffered from recurrent attacks of pain commencing with the first swallow and disappearing with the taking of additional food. During the preceding 6 months the pain had increased in severity and was not relieved by food or medication. At the time of the examination the patient complained bitterly of the pain behind the sternum which now came through to the back and of painful gas

eructations. Increased salivation was quite marked and a very troublesome feature. The appetite was poor and because of the pain the patient feared to eat. The bowels were sluggish there was at no time diarrhea or melena. The weight had gone down from 130 to 112 pounds.

The patient had undergone three complete and separate examinations with the following results. In March 1916 a diagnosis of duodenal ulcer was made. He was put on Sippy diet. He was better for weeks with a subsequent return of the symptoms. In April 1916 an examination was entirely negative for organic disease. A diagnosis of gastric neurosis was made. In May 1916 a diagnosis of spasm of the lower esophagus was made.

History. The patient had suffered from asthma and cyanosis for 10 years. Asthma was cured years ago. With this condition he had always been well. The family history revealed nothing of interest.

Physical. The patient showed signs of marked loss of weight but he was not cachectic. The pupils reacted sluggishly to light and accommodation. He had very red capillary and carious teeth. There was a moderate increase of pyorrhea. The tongue was coated. The pulse was irregular with fair volume. Systolic blood pressure was 130 diastolic 80. Heart and lungs were negative. The abdomen was flat. There was slight tenderness over the entire abdomen. No nodes or organs were palpable. Lymphatic (no enlarged supraclavicular gland) genito urinary and nervous systems were negative. Rectal examination was negative. In the gastric analysis the fasting content was 0.01 cc centimeter. There were no food remnants and no lactic acid. Free hydrochloric acid was 0.10 total 16.2 ml of 1.0 N HCl.

The urine was negative. Stool as dark brown and firm showing a faint trace of occult blood. Blood Wassermann was negative. Hemoglobin was 90 per cent. Red cells 4,400,000 white cells 7,200—a normal blood picture. A small specimen from lower end of esophagus revealed inflammation and a few suspicious cells but no definite evidence of carcinoma.

Barium suspension entered stomach without being delayed at the cardia. Undundus was narrow and rigid the barium could not be forced into it by pressure from below. A small quantity of barium remained caught and was distributed in an irregular manner in the fundus. The gas bubble was absent but as the patient swallowed a little air was seen in the fundus. The patient quickly left the stomach and was belched up. Whenever that happened the patient complained of pain behind the sternum. Peristalsis was active. The cap filled well. The stomach was empty in 6 hours. Examination of colon revealed 72 hour stasis. Diagnosis: malignant growth of fundus involving cardia and causing insufficiency.

On July 29, 30 and 31 the patient passed tarry stool. By this time the patient was confined to bed and had lost considerable weight. He was taking very little food because of the pain and was rapidly failing. On August 5 a Witzel gastrostomy was done. Operation revealed carcinoma of the fundus involving the cardia and extending posteriorly to the spine and adherent to it. Patient did not stand the operation well and died on August 31, 1916.

# CONCLUSIONS

In both cases errors in diagnosis were made several times. A survey of the literature on the subject reveals the fact that such errors are quite common. The apparent reasons for this have already been considered. If it is kept in mind that

lesions of the cardia may give rise to oesophageal and gastric symptoms and lesions of the fundus to oesophageal symptoms much could be accomplished toward diminishing the number of undiagnosed cases or toward making the correct diagnosis earlier.

Carcinoma of the fundus may give rise to oesophageal symptoms only. Such cases are particularly liable to errors in diagnosis since all attention is centered on the oesophagus. Investigation reveals nothing but the presence of oesophageal spasm and the disease is labeled functional oesophagitis. The fundus may reveal a little irregularity or bulging of the mucosa but a specimen taken even from an advanced case may show no signs of malignancy. The spread of carcinoma is submucous unless a negative specimen includes a portion of the submucosa no value can be attached to the findings. Lesions of the fundus may likewise involve the oesophagus and those of the oesophagus may in a similar manner involve the fundus. Evidence is not lacking that the cardia does not serve as a barrier to the advance of malignant growths either from the fundus upward or from the oesophagus downward. Furthermore there is anatomical evidence that such extension does occur and is quite frequent.

Malignant disease of the gastrooesophageal junction is so unlikely to be limited to only one of the three situations under discussion either in actual organic involvement or in the development of symptoms that it appears to be unwise to speak of carcinoma of the fundus of the cardia or of the last portion of the oesophagus. There appear to be sufficient grounds for referring to cancer of these areas as gastrooesophageal cancer. A further advantage in the use of this term is that it simplifies the problem of classification and incidentally makes the literature on the subject more readily available. The use of such nomenclature is sanctioned by precedent—the term ileocaecal tuberculosis.

#### SUMMARY

1. About 15 per cent of all malignant gastric lesions are situated at the fundus or cardia.

2. There is no definite symptom complex pathognomonic of carcinoma of the fundus or cardia.

3. The tendency of malignant lesions of the cardia and fundus to give rise to gastric and oesophageal symptoms respectively is responsible for many errors in diagnosis.

4. Dysphagia is the most important symptom and may not be directly due to the lesion but to an associated spasm. A slowly developing dysphagia progressively becomes worse with re-

missions occurring early if at all is strong evidence in support of a diagnosis of malignancy.

5. Loss of appetite, gas eructations and pain are the most frequent and early symptoms but they are present in so many other conditions that they acquire only secondary importance.

6. Malnutrition, cachexia and loss of weight are late manifestations and their absence does not constitute evidence against malignancy.

7. Enlarged supraclavicular glands are rarely present and if present occur late.

8. Achylia and anemia are not reliable signs but are of secondary importance. If present anemia is a late manifestation.

9. Occult blood in the stool is an almost constant finding.

10. Oesophagoscopy is of little or no value as an aid to diagnosis except in carcinoma beginning in the lower oesophagus particularly in the presence of malignant ulceration.

11. The most important method of diagnosis is careful radiographic and radiographic examination in all positions. The direct and indirect signs are enumerated.

12. The use of the term gastrooesophageal carcinoma is suggested for malignant lesions involving primarily the terminal oesophagus, cardia or fundus.

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# EDITORIALS

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## SURGERY, GYNECOLOGY AND OBSTETRICS

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MAY 1928

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### SURGICAL TREATMENT OF THE NEURALGIAS

SINCE Spiller suggested section of the posterior root of the gasserian ganglion in 1899 for the surgical treatment of trigeminal neuralgia no new principle of treatment has been introduced. There have been modifications in technique but only with the purpose of reducing postoperative mortality and morbidity. Experience with section of the larger nerve trunks and avulsion and section of the peripheral nerves has demonstrated how futile such measures are to produce anything but temporary alleviation of symptoms. The injection of alcohol by various methods which afforded temporary relief was a valuable addition to the treatment particularly in early cases and in those in which the physical condition of the patients rendered surgical procedures too hazardous. With the lapse of time however the conception has been confirmed that in order to effect permanent cure the trigeminal nerve must be interrupted between the gasserian ganglion and the brain stem.

When glossopharyngeal neuralgia was recognized and established as a clinical entity

the failure of operations on the nerve trunks to bring about permanent relief led Adson to adopt a procedure analogous to that practiced in trifacial neuralgia namely severing the glossopharyngeal nerve proximal to the superior and petrous ganglia. Although sufficient time has not elapsed to establish evidence of permanent cure the relief following the procedure extending in one instance over 20 months and experience with the analogous procedure in trigeminal neuralgia bespeak success.

Because of the satisfactory results of these operations especially in cases of trigeminal neuralgia section of the posterior root for complaints resembling trifacial neuralgia became inevitable. The argument was advanced that if the face were anæsthetic no pain would be felt. In some instances the differential diagnosis was confusing in others there were only slight resemblances to the classical syndrome. Critical study of this group of cases has demonstrated that as a rule the pain is pulling drawing deep seated and constant in character. If paroxysms occur they are infrequent and are likely to be prolonged for hours at a time. The complaints are as a rule bizarre. It has been emphasized repeatedly that trigeminal neuralgia is a disease of unswerving constancy and that variations from the accepted syndrome constitute different forms of disease demanding different methods of treatment. Most of these cases are to be classified with migraine the psychoneuroses the changes incident to senility and entities the nature of which has not yet been determined. It is now commonly agreed that not only is operation in these cases ineffective,

but in certain instances it aggravates the condition. Even cervical sympathectomy after previous section of the posterior root of the gasserian ganglion has failed to relieve the patient's complaint.

A group of patients who have received less consideration are those suffering from the disability incident to the pain and paresthesia following herpes ophthalmicus. Adson reported 2 cases in which he cut the posterior root of the gasserian ganglion without success. The explanation that failure resulted because of involvement by the underlying process of structures within the brain stem has recently been corroborated by Lhermitte and Nicolas whose contribution shows that the essential pathological change of herpes may involve simultaneously the ganglion and the central grey matter.

That the application of the principle of section of the posterior root for the relief of other types of pain has not been successful does not detract from the original success of the procedure but merely limits its applicability to one form of human scourge. It has become obvious that section of the respective posterior root is the only curative measure for trigeminal and glossopharyngeal neuralgia and conversely that this type of operation is effective only in cases of true paroxysmal neuralgia.

JOHN B. DOYLE

### WHY SURGERY IS INDICATED IN HYPERTHYROIDISM

**W**ITHIN the past two decades our knowledge of the glands of the body both duct and ductless has markedly advanced. This is especially true of the thyroid gland. We now associate the pathology of the thyroid with the clinical symptoms of disease of this gland and the clinical symptoms with the metabolic rate. The etiology of goiter is very obscure, there being

four theories regarding it: (1) The earth and water and (2) the toxic infective theories (3) the theory of the absence of iodine from food and (4) that of multiple causation in relation to general hygiene. Since the cause of goiter is unknown to us, naturally the medical treatment is non-specific. It is true that improvement may result from many different forms of treatment, but it is equally true that improvement often absolute cure will follow in a certain small per cent of cases even though no treatment is instituted. This latter is especially true of cases of hyperplastic goiter. Unfortunately most of the patients die before the spontaneous cure occurs.

Simple endemic goiters, as well as those of adolescence and pregnancy, should be treated medically. Colloid goiters, due to iodine deficiency, can usually be cured by the administration of iodine or thyroxin. To the experienced thyroid surgeon they become surgical only in the presence of cyst formation and pressure symptoms.

There is no doubt that the epithelial cells of the thyroid can be altered and even destroyed by the action of the X rays and thus their function can be modified and even abolished. But according to the debate formed on this subject, the X ray is curative in a very small number of cases. Crile judging his results by means of the respiratory exchange places the efficacy of radiotherapy between that of simple ligation and that of resection of the gland. One must not forget that the action of the rays is markedly cumulative; that a result apparently favorable at the beginning may eventually turn out to be excessive; that the adhesions after radiotherapy are often more marked than those following surgical intervention; and that when these patients do come to operation what may have been a comparatively easy surgical procedure is made very difficult.

Surgical treatment offers to the patient suffering from hyperthyroidism either from exophthalmic goiter or toxic adenoma (nodular goiter with hyperthyroidism—Rienhoff) by far the best chance for recovery. A conservative estimate of results after 5 years shows that 60 per cent of the patients are cured, 30 per cent greatly benefitted, 7 per cent improved, and 3 per cent unimproved. After the same period a fair estimate of the medical treatment would probably be a reversal of these figures.

These 40 per cent partial or complete failures as you choose are explained by Richter upon the basis of the removal of insufficient gland with resulting residual symptoms and a persisting increased basal metabolic rate. In his own work he reports 93 per cent cures, patients free from any evidence of thyrotoxicosis. Undoubtedly the work of Richter will have a stimulating effect on thyroid surgery and the percentage of definite cures.

The administration of iodine in the form of Lugol's solution as advocated by Plummer as a preoperative procedure in exophthalmic goiter is routine in all goiter clinics. Its effect is so remarkable as to cause it to be considered a specific in the preoperative preparation of exophthalmic goiter patients. It is not to be considered as a curative agent for its effect is transient. When the maximum effect of the drug is obtained, that is an artificial remission, usually within 10 days as manifested clinically and by the basal metabolic rate, your patient is ready for surgery. Surgery should not be delayed as the efficacy of iodine diminishes with each subsequent course.

The use of iodine in the preoperative preparation of patients with toxic adenomata is a debatable question. Plummer still believes

that it should not be used while Graham and Cutler advocate its use. With the large number of cases of iodine hyperthyroidism being reported, it may be wise to abstain from its use until more conclusive evidence has been offered in its favor.

Digitalis is useless for the purpose of counteracting the nervous and toxic acceleration of the pulse. Its action is entirely superfluous because the heart is already overstimulated by the hyperthyroid condition, the only effect of the digitalis therefore being a toxic one. Plummer even goes so far as to state that the very definite reduction in mortality at the Mayo Clinic in patients with toxic adenomatous goiters to less than 1 per cent was directly due to stopping the use of digitalis. However, it should always be given in cases of circulatory troubles due to a cardiac lesion.

Our surgical patients are very exacting; they demand to know the risk, to have a scar which is scarcely visible, their recurrent nerves and parathyroids must remain uninjured, sufficient thyroid must be left for future requirements, and above all they must be guaranteed against a recurrence. In spite of all these demands, the well-known goiter clinics of our country show a mortality of less than 1 per cent for all types of goiter. So in speaking of other than surgical treatment for the toxic thyroid, we should not compare but should contrast. Until the etiology of goiter is discovered, surgery is the method of treatment and the indication for operation is the diagnosis. The case of the surgeon is ably summed up by Richter: "I have not had failures from my thyroidectomies though I have not infrequently failed to accomplish a thyroidectomy in the first attempt."

J. E. STRUTHERS

# MASTER SURGEONS OF AMERICA

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## EDWARD LAWRENCE KEYES

**M**EN stamp their personality upon their time in one of two ways. Some leave the impress of their adventurous and romantic characteristics; they are the discoverers, the inventors, the poets. Far more numerous are those who impress their contemporaries with the very essence of their character: their industry, their intelligence, their honesty, rather than by a definite invention or discovery, such are the statesmen, the educators, the scientists. The happy combination of the two is rare, yet it was found in Edward L. Keyes. A M. D. LL. D. K. S. G.

Dr. Keyes was born August 8, 1843, at Fort Moultrie in Charleston Harbor, South Carolina, of Erasmus Darwin Keyes, who later commanded the Union troops at the battle of Fair Oaks and was ultimately Major General of Volunteers, U. S. A., and Caroline M. Clarke of Brooklyn, New York. His forbears were Puritan; his education was received at Dedham, Massachusetts, and at Yale (A. B. 1863), where he rowed on the Freshman crew and was a member of the Scroll and Key Society.

After a brief staff captaincy under his father at Washington during the closing months of the Civil War, young Keyes entered New York University Medical College, graduating in the customary years in the spring of 1866. Under the advice of his preceptor, the professor of surgery, William H. Van Buren, he then immediately proceeded to Paris to specialize in dermatology. After a year in Paris, he returned to New York, where he offered himself to Dr. Van Buren as an assistant, only to be informed that Doctors Swift and Gouley already filled all the available space, but that he, Keyes, could do odd jobs if he wished. His acceptance of this humble prospect and his industry thereupon were rewarded when shortly the dispute about the invention of the tunneled urethral sound dissolved the association between Van Buren and Gouley, while Swift died, leaving Keyes as first assistant of the town's brilliant and fashionable surgeon.

Curiously enough, in view of his later surgical developments, Keyes' special qualifications as a dermatologist seem to have sidetracked him from that career as general surgeon to which the assistant of the professor at the University and the visiting surgeon to the New York Hospital might well have aspired. We find him holding the first clinic in dermatology in the United States at the



EDWARD L. KEYES  
1843-19 4





Woman's Medical College in New York in 1870. The next year he was professor of dermatology at Bellevue Hospital Medical College to which he joined the specialties of syphilology and genito urinary surgery thus beginning his surgical career as a specialist with a hospital appointment first at the Charity (now City) Hospital and later at Bellevue Hospital where he established the first ward in the country devoted exclusively to genito urinary disease.

He continued to teach until 1892. His sound logic, his gifts of expression, his sympathetic personality and his keen sense of dramatic values made him a most effective clinical lecturer. What old student of his will forget the first words of his opening lecture? The Professor enters briskly, greets his students in a few words as a patient is being wheeled in on a stretcher, then he turns to the patient, whips the sheet off the ulcerated nakedness. 'Gentlemen, this is syphilis!'

We find him in his youth combating the errors of the day, proving by experiment that clean urine injected into the peritoneum does not infect, that urethral chill does not follow the passage of a sound unless this enters the deep urethra, warring with Otis on the latter's theory as to strictures of large calibre, attacking successfully the electrolytic treatment of urethral stricture and spreading the whole of his scientific knowledge upon the pages of that classical textbook on genito urinary diseases and syphilis by Van Buren and Keyes of which the first edition appeared in 1874 and which has been a standard textbook of urology from that day.

Doubtless his greatest contribution to scientific medicine was his paper on the clinical effects of small doses of mercury read before the International Congress of Medicine in Philadelphia in the year 1876. At this time current practice regarded syphilis as an evil only one degree worse than mercury. The treatment of the disease consequently consisted chiefly in the administration of iodides and various 'potent herbs' of which the magic formulæ persist to this day while here and there an adherent of mercurialization subjected his patients when their disease became unbearable to injunctions which were continued until the patient had spat out such teeth as he was willing to lose.

As Keyes used to tell the story it was the insistence of Dr. Piffard before the New York Pathological Society that mercury was totally evil which first set him thinking it might be good. Piffard drove his logic too hard and Keyes went back to his home in Eighth Street wondering whether it was quite as bad as all that. A new hæmocytometer was ordered from Paris. Keyes and his friend Stimson proceeded to dose themselves with mercury and check the results with blood counts. Syphilitic and non syphilitic patients at the hospital were submitted to a like investigation and it was shortly proved that mercury in small doses is a tonic. Upon this thesis was founded the method of internal administration of the drug advised by Keyes and generally adopted in this country during the last 20 years of the nineteenth century.

In his latter years though he continued always to consider himself a general practitioner (and was once jeered at by his fellows for missing a meeting of the American Association of Genito Urinary Surgeons because of an obstetrical case) his originality manifested itself more in the duly spoken word and in the activities of his pupils Alexander Fuller Chetwood and Keyes Jr. The most notable contribution of these men were probably those of Fuller in originating the treatment and especially the surgery of the seminal vesicle (and incidentally the first crude theory of the metastatic origin of arthritis) and in the establishment of suprapubic prostatectomy upon its modern basis. Of these items the ones relating to the seminal vesicle and rheumatism seem to have belonged wholly to Fuller but the details of prostatectomy as described by Fuller were those of the operation performed by both.

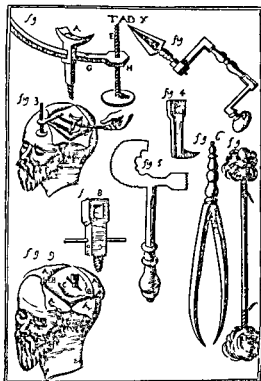
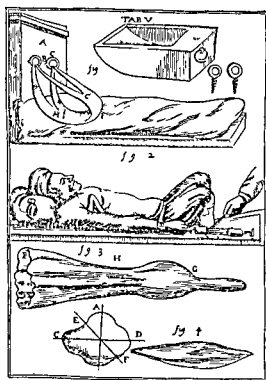
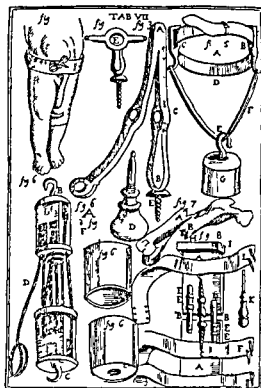
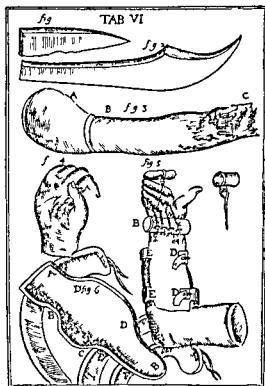
So much for the inventor. The man was bigger. Though no organizer his authorship of an accepted textbook his pellucid honesty his gift of precise speech his kindness to all made him inevitably the founder and first president of the American Association of Genito Urinary Surgeons. Later his gifts in oratory won him the central oration at the opening of the New York Academy of Medicine in Forty Third Street. He served a term as Vice President of the Academy. In the privacy of his office he was the true helper of the sick interested far less in organization progress or individual invention than in solving the puzzle presented by each patient in his turn. Here the simple nobility of his character and his understanding sympathy gave him that hold upon his generation which is the physician's great reward. In his youth he had been isolated a month with Charles O'Connor when the latter returned from Europe with smallpox and years after when the man who smashed the Tweed ring was dying at Nantucket and was told that the family had sent for Keyes he said

Don't let him come this time I want to die.

He himself succumbed to the old man's friend pneumonia at the age of eighty on January 4 1924.

E L KEYES





# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

BY ALFRED BROWN, M.D., F.A.C.S., OMAHA, NEBRASKA

### THE SURGERY OF FABRICIUS HILDANUS

**S**URGICAL Observations were the fashion in the literature of the late sixteenth and early seventeenth centuries. Clinical Surgical Pathology was coming into its own. For the most part these Observations were rather hazy and miss reports of cases—usually uncoordinated and following no definite schema. Some of them were of considerable value to surgical development, all are interesting to present-day readers, peculiar and exaggerated though some of them may be for in this lies much of their charm. Occasionally a surgeon is found who went beyond the mass of his contemporaries and from his study and experience produced a work of more outstanding merit than the usual Fabricius Hildanus or to give him his full name, Wilhelm Fabrici Hildanus, belonged to the group of Master Surgeons of his time and his superiority is so evident that he has been called the German Pare.

He was a barber surgeon but contrary to the rule he was also a well-educated man. He first attended a school at Cologne where he learned Latin and thus fitted himself for the study of the eminent surgical authors. When sixteen he took up the study of medicine under various wound surgeons: Dugens, Slotanus, Solenander, who was educated in Italy, and Weyer. He probably studied also under Bartisch at Metz. He went to Geneva when he was twenty-six years of age and began to practice, and the following year married Marie Colinet, who was versed in midwifery and helped him in his work. In later years, when Fabricius was away on one of his long consultation trips, his wife with the assistance of his students cared for his practice. With his advent in Geneva, Fabricius' reputation and practice began to grow. Though he never served actively in war, he was considered one of the great wound surgeons, and his first work of importance was on burns—wherever he went he was in constant search for information and particularly postmortem and anatomical work. Among other activities he articulated a skeleton which he presented to the City Library of Berne to take the place of the one presented by Pierre Franco which had fallen apart. Constantly moving from city to city, he never finds time to write his Observations, and his first One Hundred appeared at Basel in 1606. Then followed numerous other works—on gunshot

wound, war surgery, the necessity for a knowledge of anatomy, lithotomy, four hundred more Observations, and others. His work was monumental. In his old age, when sixty-eight years had taken their toll, he felt his powers waning and, also experiencing the tortures of the gout, he withdrew to a practice just outside the city of Berne. Finally in 1634 he died.

It was not until after Fabricius' death that his work was collected and the most important portions gathered into a single work. The first edition, written in Latin and published by J. Beyer at Frankfurt am Main, appeared in 1646. It was reprinted many times later and translated both into French and German. The volume illustrated here is the edition of 1670, published at Geneva by Jean Anthoine Chouet and translated from Latin into French.

The work has been arranged in the form of the textbook of the day and divided into chapters or books. The first, tumor against nature, includes also inflammatory conditions and hernia; the second, surgical observation of wounds, the third, ulcers, fistulas, etc.; the fourth, fractures and dislocations; the fifth, the operations of surgery; the sixth, general surgical observations and finally an addendum, a treatise on gangrene and sphacelus. Following the index and concluding the volume are the illustrations, printed from engraved copper plates.

Fabricius Hildanus, like his French predecessor Pare, was an indefatigable worker, a careful observer of minute clinical detail and a student of morbid as well as normal anatomy. When one seeks for any one great discovery or great advance in surgery to account for the greatness of the man, it cannot be found. To be sure, he was probably the first to remove a metallic foreign body from the cornea with a magnet, and he invented the ear speculum. As an operator, he was conservatively daring, not shrinking from amputations of the thigh or the opening of deep abscesses with the cautery and scalpel, but these are details, important though they may be. Rather his greatness lies in his painstaking methods and attention to detail. His friendships with his contemporaries must also be mentioned. Much of the material for his collected work came from his letters to his friends. One feels that for him his motto, *Omnis tutela a Deo*, could not have been better chosen.



selected about 400 French 600 German 1200 Italian and 1600 Spanish words having bacteriological significance and has given the English equivalents. The words from each language are grouped separately. While no claim is made for completeness of selection yet the more important and usual words have apparently been successfully chosen and intelligently translated. Because of its convenience of size and content the book should prove of value to those who have occasion to read or refer to the bacteriological literature of these several countries.

ALEXANDER A. DAY

THIS cleverly assembled little book on advances in anatomy aims to present some of the recent advances in anatomy as an exhibit for the enlightenment of such as might not be aware that anatomy is advancing. As a missionary tract it should do particularly well in the author's homeland where the sterile blight of traditional anatomy continues and the experimental method as practiced in America remains the monopoly of physiologists. This particular British skeleton is deliberately rattled by the author in the introduction when relating a conversation with a physiologist who told him his task was easy since there are no recent advances in anatomy. One cannot imagine a physiologist on this side of the water talking so—unless indeed he were purblind and gouty.

Nor can one agree with the author's further contention that the recent advances in anatomy are merely typical bits of physiology that anatomists try a hand at. It so happens that the physiologists commonly concerned with functional activities *per se* whereas your anatomist usually inclines to use physiology as a tool for the explaining of the anatomical pattern at the bottom of it all. An inspection of the table of contents or a casual turning of the pages of the present volume will convince even the casual browser that it records the work of anatomists *sensu stricto* and not of apostates to another science.

The author further confesses that this new outlook is the result of a year's sojourn at Johns Hopkins which exercised a great influence in determining his attitude to the venerable subject of anatomy. A moderately captious critic might remark at this point that the wonder of it all must have rendered him myopic as well for many of the topics and the viewpoint adapted reflect the local attitude there even sometimes to the unjust suppression of depreciation of good data so unfortunate as to emanate elsewhere. Lest this stricture appear unjust one may by way of example inquire why the great controversy in the history of American anatomy that of the origin of endothelium now settled at the expense of Hopkins' prestige should be omitted from consideration in its proper place?

As a whole the topics comprise an interesting and representative selection although they must remain as samples reflecting the personal interests of an individual. Whereas laymen will find this book too technical and general biologists may be disappointed in the selection of topics those interested in the medical science should welcome it as an interesting and significant review—and perhaps of revelation.

The several topics comprise sixteen chapters. Microcirculation tissue culture oestrus ovulation and mensturation the youngest human ovum growth center and organizers the morphogenesis of nerve fibers vital staining the origin of the cells of the blood the cerebrospinal fluid postural organs the red nucleus the extrapyramidal system the cerebellum the projection of the retina in the central nervous system protopathic and epicritic sensation and sensory anatomy. There are numerous illustrations brief and ill balanced bibliographies and in adequate index.

L. B. ARLEY

THE object of the book *True Hardening of the Colon* is to describe an ailment which the author believes has not been generally recognized by the medical profession. He points out that Sir Charles Sherrington has shown that a muscular fiber may as a result of nervous control become fixed in any condition of extension or contraction and become static. This is in contrast to the ordinary contractile mobile power of muscle.

The author believes that the colon as well as other portions of the gastro intestinal tract may become afflicted with more or less persistent static fixation. This he terms tonic hardening of the colon. Objectively this condition results in a hard palpable colon which is tender to pressure. Subjectively the patient is afflicted with multitudinous symptoms which run the gamut of what are usually considered functional nervous symptoms. The author lists crying pells screaming fits neuralgic pain mental depression labyrinthine vertigo hyperacidity lapse of memory phobias vasomotor symptoms lassitude reflex vomiting as well as pain in the abdomen which occurs after meals on awakening in the morning and coming on after midnight.

The treatment consists of giving liquid hydrargyri perchloride and liquid ferri perchloride as an intestinal antispasmodic on occasions lactic acid bacilli at other times and in other instances atropine. He advises a diet which eliminates coarse food and vegetables rich in cellulose.

In a general way the picture described corresponds to what is ordinarily called spastic colitis with marked neurotic manifestations.

The author's views are advanced with keen enthusiasm in the subject. It is not a book for Missourians.

V. C. DAVIS

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## EIGHTEENTH ANNUAL CLINICAL CONGRESS IN BOSTON

UNDER the leadership of a strong and representative committee of Boston clinicians a program of clinic and demonstration in the hospital and medical school of that great medical center is being arranged for the eighteenth annual Clinical Congress of the American College of Surgeons during the second week of October from Monday October 8th to Friday the 12th inclusive. All departments of surgery—general surgery gynecology obstetrics orthopedic urology and surgery of the eye ear nose throat and mouth will be represented in this program which will include lectures and demonstrations at the following institutions: Harvard University Boston University and Tufts College medical schools and the following hospitals: Beth Israel Boston City Boston Dispensary Boston Irving In Peter Bent Brigham Kolbert Brigham Cambridge Currier Children's Deane Faulkner Free Hospital for Women Huntington Memorial Long Island Mis ahusett Eye and Ear Infirmary Massachusetts General Massachusetts Homeopathic New England Baptist New England Hospital for Women and Children and St Elizabeth.

The morning of Monday October 8th will be devoted to the annual hospital conference which will be continued on Tuesday and Wednesday. Operative clinic and demonstrations in the hospital and medical schools are scheduled for

Monday afternoon and for both morning and afternoon on each of the three following days. A preliminary clinical program is to be published in an early issue of SURGERY GYNECOLOGY AND OBSTETRICS.

As at previous sessions a series of evening meetings is planned and the programs therefor are now being prepared by the Executive Committee of the Congress and will be published in this journal at an early date. These will include a number of highly interesting papers on various surgical subjects of present day interest presented by eminent surgeons of the United States Canada and Great Britain. At the International Meeting on Monday evening to be held in Symphony Hall the President Elect Dr Franklin H Martin will be inaugurated. Another feature of the evening program will be the John B. Murphy Oration in Surgery. The meetings on Tuesday Wednesday and Thursday evening will be held in the grand ballroom of the Copley Plaza Hotel. On Friday evening the annual Convocation will be held in Symphony Hall.

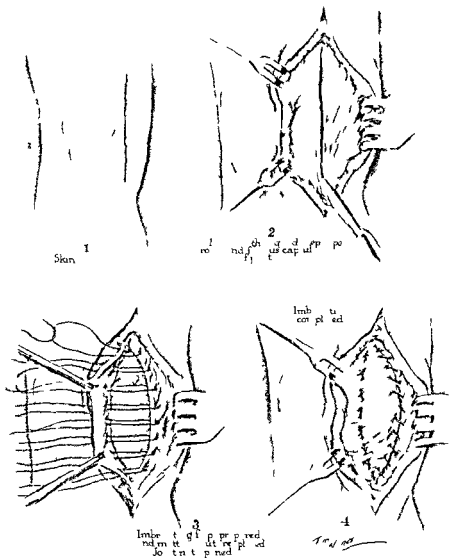
Since the last session of the Clinical Congress in Boston in October 1917 a number of new hotels have been built including the Statler with 1300 guest rooms. Several of the older hotels have been rebuilt or enlarged so that there are now ample first class hotel accommodations in Boston for all who will attend.



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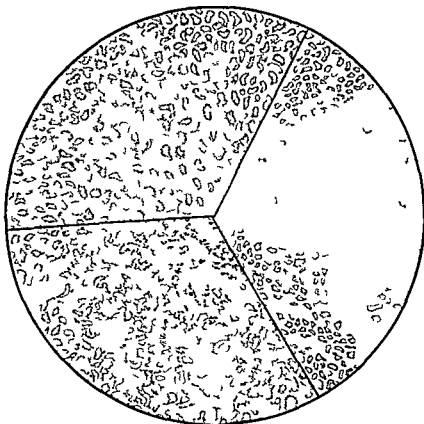
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# SURGERY, GYNECOLOGY AND OBSTETRICS

AN INTERNATIONAL MAGAZINE PUBLISHED MONTHLY

VOLUME XLVI JUNE 1928 NUMBER 6

## SURGERY OF THE PANCREAS

WITH SPECIAL CONSIDERATION OF ACUTE PANCREATIC NECROSIS<sup>1</sup>

By PROF. DR. V. SCHMIEDEN and DR. W. SIEBING, FRANKFURT A. M., GERMANY  
S. G. T. U. by H. H. L. C.

A QUARTER of a century ago in a lecture before the Congress of American Physicians and Surgeons on "The Present Status of Pancreatic Surgery with Especial Emphasis upon Injuries and Inflammations" the famous German surgeon von Mikulicz designated pancreatic surgery as the least complete chapter in abdominal surgery. Even today there are numerous unsolved questions in practical as well as scientific pancreatic surgery. Why do so many people die from this acute dread disease? is the question that has troubled the surgeon for the past half century. This is especially true since Baser in 1882 published a description of fat necrosis. Gussenbauer was the first to record a case of pancreatic surgery, his report being made in 1883. Since Halsted in 1898 described an operative procedure for the cure of acute pancreatitis and Koerte in the same year set forth his very comprehensive and fundamental work which seemed to cover all of the then current knowledge of pancreatic disturbances very little of note has been published on the subject.

However experimental research on the pathogenesis of pancreatic surgery has added a noteworthy chapter to the unfinished history. This experimental research aided by surgical autopsies has led to a complete understanding of the devastating effect of the pan-

creatic enzyme when placed extraneously and to an understanding of the too early activation of the digesting enzyme in the gland itself coupled with autodigestion of the pancreas.

As a result of clinical observation and experimental research there have been developed in the past 20 years systematic operative principles which have brought about successful results in pancreatic surgery. There has been no sudden marked progress which can be compared to the solution by the internist of his most serious pancreatic problem namely the treatment of diabetes through the use of insulin. Because of the physiological and pathological nature of the pancreas this branch of surgery has developed slowly and even now it does not seem likely that more rapid progress will be soon forthcoming.

As hypothetical theories are gradually replaced by established facts the surgeon will approach the practical solution of the clinical problem and will eventually evolve an ideal treatment and possibly adequate prophylactic measures.

Our opinion upon the present status of pancreatic surgery is based not only upon our own experiences and the reports in the literature but upon a study of 2137 cases which have been treated in the past 8 years. Questionnaires were sent to over a hundred clinics and hospitals and a general report on the answers

was presented by von Schmieden at the Society of German Surgeons in 1927. It is impossible to give here a complete review of all of the information obtained so we will limit our discussion to the subject of pancreatic necrosis.

The anatomicopathological picture (Fig. 1 frontispiece) shows simultaneous necrosis in inflammation and hemorrhage. In a discussion as to which of these plays the primary role Opies and Gulekes are of the opinion that necrosis is the dominating factor. This opinion has come to be the generally accepted one. The earliest studies naturally show the unmixed picture. But from this one cannot conclude that the all important pancreatic drama may not be secondary to a primary inflammation—pancreatitis—with necrosis and hemorrhage secondary or that hemorrhage as a result of syphilis or arteriosclerosis (pancreatic apoplexy) may be a primary pathological change. Hemorrhage is followed by necrosis and inflammation due to invasion of the pancreatic enzyme which immediately becomes activated. The explanation of both Bergmann and Guleke is of utmost importance in understanding the pathogenesis of this process. They believe that the symptomatology and course of the disease is secondary to an intoxication from the autolytic destruction of the pancreas. The trypsin itself is not the direct causative factor but it is a protein formed by the pancreatic autolysis. It is rapidly absorbed and death results in a few hours before resistance is developed either by an inflammatory process or by anti-toxins.

The changes in the pancreas vary tremendously in type and degree. Early alterations consist of edema often bile stained with a serous infiltration of the entire body of the pancreas. There may still be however a complete recovery without damage to the parenchyma (Zoepffel). In an advanced stage the gland resembles variegated marble in color because of the diffuse swelling and hemorrhagic infiltration (Fig. 2 frontispiece). As a result of further destruction there develop structureless necrotic tissue masses ranging in color from brown to dull gray so that ultimately the gland assumes a cooked

appearance. In the presence of excessive hemorrhage there may be a complete appearance of the tissue structure and the pancreas is changed to a blue red blood clot. The typical disseminated spots chalky or opaque of fat necrosis may appear within hours. These spots together with the peritoneal effusion give the surgeon a diagnosis pointing to the pancreas as the causative organ. Langerhans, Hildebrand and Flexner believe that the enzymic action rather than the bacterial action is the cause for the splitting of the fats the changing of the neutral fats to sodium and calcium soaps. They are found in the gland itself in the peripancreatic fat and scattered throughout the entire peritoneal cavity as well as the retroperitoneal subpleural mediastinal pericardial and even subcutaneous tissues they have even been described symmetrically scattered about in the extremities (Jenkel).

The blood stream is the only accepted means by which the enzyme which splits the fat in the atypical distant places is spread (Eppinger, Iayr and Martin). In the peritoneal cavity the reaction is due to direct contact with the enzyme and most frequently the toxin is conducted by the lymphatics to other areas. Istock working in Guleke's clinic has recently demonstrated this by new and important evidence.

Should this pathology be survived there still is the further danger from the extension of the process to the peritoneum (peritonitis toxica) and further to the retroperitoneum and eventually it is possible even to the pleura (Clairmont). In these locations the peritoneal exudate containing the enzyme acts in its usual manner and lead to tissue destruction a primary sterile inflammation with a secondary bacterial infection the original bloody serous exudate becoming purulent. As a result the glandular parenchyma being poor in connective tissue rapidly disintegrates giving off pancreatic sequestra which subsequently drain out in masses together with the operative discharge. The organ may become swollen to the size of a man's fist and the patient is endangered by still other complications. In the prolonged subacute type of the disease there may be a

downward seeping of the pus and if the patient survives the intoxication and peritonitis he is still liable to suffer from a pyemia with or without mesenteric thrombosis or else he may suffer from an involvement of the portal veins

The normal protective tissue reaction is everywhere decreased by the corrosive action of the gland secretion. There may occur perforation of such viscera as the stomach or the bowel ruptures in the neighboring body cavities or, severe even fatal hemorrhage of the numerous blood vessels surrounding the gland. Occasionally a case may develop a pancreatic pseudocystic disintegration cavity which should be recognized as part of the healing process.

In spite of the fact that the methods of pathogenic development are numerous the etiological causes will be found to be even more frequent. Neither experimental results nor clinical observations have solved the problem of prophylaxis from an etiological aspect. We present here only those experimental results which in dogs either through mechanical or toxic tissue damage or by blood vessel and tissue changes have produced the homologous to the human clinical picture. The initiating factor for the development of the morbid process has however not yet been demonstrated in a manner free from all possible criticism. We do know that the lymph channels and blood vessels are the most important paths through which the most destructive agents flow (Fig. 3).

There have been clinical observations of all these etiological possibilities. Duodenal diverticulitis is one of the least recognized factors in acute pancreatic necrosis but its gene is has been forcibly established by the work of Forssell and Key. Case Wilkie Akerlund and Clairmont.

Of greater significance are the variations in the pancreatic ducts and their mouths. Osler explained these variations in the relations by the embryological development of the gland. Clairmont differentiates ten major types. By means of iodine injections in the tail of the pancreas in cadaver preparations we have been able to demonstrate even more anomalies of the duct system.

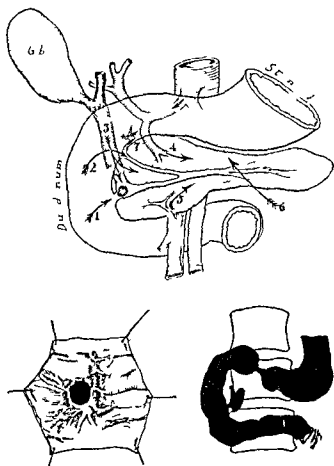
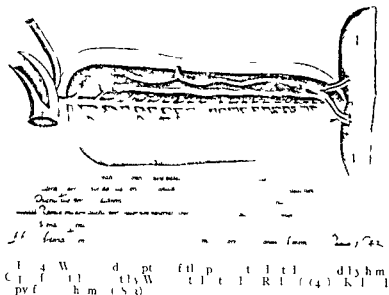


FIG. 3. Schematic description of the avenues of development of pancreatic necrosis: 1 through the duct of Wirsung from the duodenum through the duct of Santorini; 2 from the biliary ducts; 3 from the arteries; 4 from retrograde emboli through the veins; 5 from traumatic; 6 from duodenal ulcers through the lymphatics. Fig. 3a (lower left) Duodenal diverticula near Vater's papilla; b (lower right) Koentgen demonstration of diverticulum by von Akerlund.

Opie was the first to find at autopsy a small gall stone fixed in the ampulla of Vater and it was he who explained the development of acute pancreatic necrosis as secondary to the back flow of bile into the pancreatic ducts. Since then the topographical course of the ductus choledochus and the duct of Wirsung together with their different types of union have been given the utmost consideration (Mayo Robson Osler Bunker etc.).

The results of research concerned with the examination of the conditions in which bile can invade the pancreatic ducts are extremely contradictory. While Mann and Giordano found it anatomically possible for a gall stone to block the papilla in such a manner that bile may invade the pancreatic ducts





in 5 per cent of the cases of Juliff and it is true in 4.5 per cent of the cases and likewise Cameron and Nobel in 66 cases in 100 examinations. Our investigation demonstrated that in 8 of 5 cases it was possible after clamping the papilla of Vater to fill the tail of the pancreas from the bile ducts or vice versa.

Our limited observation is of particular value inasmuch as cases of papillary stone were found among 1 case of acute pancreatic necrosis with an associated cholelithiasis (Fig. 5).

The recognition of the extreme significance of disease of the biliary ducts in the etiology of acute pancreatic necrosis is not only of marked importance in understanding the pathogenesis but also for diagnosis, therapy, and prophylaxis.

While it has been customary to look upon the simultaneous presence of cholelithiasis and pancreatic necrosis as coincidental it is noteworthy that this combination is more frequently found when the surgeon looks especially for this possibility. This is definitely demonstrated by a comparison of the figures collected from our questionnaire with those of Culeke. There were 894, 69.8 per cent cases of biliary duct disease in 1,278 cases of pancreatic necrosis operated upon whereas

Culeke questionnaire in 194 comprising 437 cases had 68 or 39 per cent of simultaneous cholelithiasis (Fig. 6). The percentage of fixed choledochus or papillary stones in the Culeke statistics was surprisingly small while in our report there were 174 common duct stones and 57 papillary stones. Our own material in which the role of the biliary passages was especially noted shows 31 cases of biliary stone in 38 cases (81 per cent) and of the 13 were common duct stones 7 of which were in the papilla.

In what fashion then does the dilated gall bladder injure the pancreas? The clear cases are those in which acute pancreatic necrosis results from the fixation of a stone in the ampulla of Vater. The same mechanical damage occurs here as in the experimental production of acute pancreatic necrosis. Stasis of the secretion and elevation of the pressure in the pancreatic ducts together with chemical trauma from the bile and bacteria are the provocative factors. The passage of concretions with their temporary fixation of the ampulla of Vater may act in the same manner. At the time of operation the stone may be found in the bowel (Jung, Zoepfel, Eich). It may not even be found at autopsy so that definite proof of its existence may be

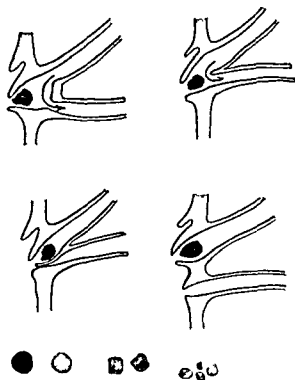


Fig 5 Obstructive stones in the papilla of Vater and the various types of mouths of ductus choledochus and pancreatic ducts. Below are the stones which have caused the acute pancreatic necrosis contrasted with pepper berries.

lacking. On the other hand the stone may fall back into the dilated common duct after being temporarily fixed at the ampulla. Then there is still the possibility that the successful passage of a stone through the papilla may stretch it and cause it to gape so that the duodenal content may invade the duct of Wirsung and activate the pancreatic enzyme. Stones which are situated in the supraduodenal part of the common duct can have no direct mechanical effect upon the pancreatic ducts but may induce spasm of the sphincter of Oddi so that regurgitation of bile into the pancreatic ducts results. A diseased gall bladder—a cholecystitis—may produce the same effect even though the common duct is free from stones. Obstruction of the common duct above the papilla may cause bacteria and an exudate containing bile from the intra-pancreatic biliary ducts to invade the adjacent pancreatic tissue and may give rise to an associated pancreatitis. Finally invasion of the lymph glands in the head of the pancreas from the lymphatics of the gall bladder may

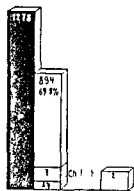


Fig 6 The overwhelming significance of biliary duct stones associated with all other etiological factors in the case of pancreatic necrosis operated upon in our collected statistics.

lead to stasis and activation of the pancreatic enzyme.

In occasional cases it is often difficult to demonstrate the genetic connection between cholelithiasis and pancreatic necrosis but its tremendously greater frequency as contrasted with all other known etiological factors justifies the assumption of pancreatic necrosis as a complication of cholelithiasis. Early operations for cholelithiasis are therefore amply justified (prophylaxis). As a rule pancreatic necrosis follows a neglected chronic cholelithiasis (important for diagnosis) but this grave disease can occur early without any evidence of a common duct complication (acute pancreatic necrosis following labor in a primipara). In our youngest patient 13 years old the unmistakable etiological factor was a stone about the size of a pepper berry in the papilla.

Undoubtedly a minute examination of the biliary ducts is a definite prerequisite in every case of pancreatic necrosis operated upon. The correct methods of treatment have been established as far as the treatment of gall stone disease demands. The purpose of this part of the operation must therefore be to conduct the bile away in the quickest and simplest manner and to drain the pancreatic ducts. Rapid gall bladder drainage will suffice if the large bile ducts are free from stones. If the condition of the patient will permit we agree with Nordmann von Haberer and Zopfer that the operation of choice is cholecystectomy with choledochotomy. Cholecystectomy alone is unsatisfic-

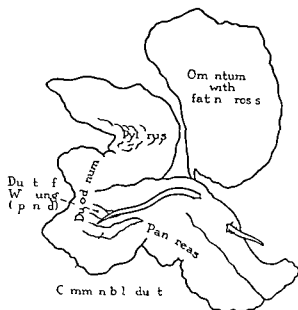


Fig. 7. A. T. P. t. l. by. f. th. d. t. f. W. h. i. y. a. Th. p. t. t. s. y. a. s. f.  
g. p. t. d. p. o. h. ft. th. t. f. th. d. l. th. l. d. l. ft. p. t.

tory as it not only hinder drainage but increases the pressure in the biliary duct system. Internal biliary duct anastomosis (choledochoduodenostomy) must be condemned because the peritoneum in the neighborhood of the pancreas has poor adhering qualities and at this point all intestinal sutures are unreliable. Moreover such operations take too much time. The statistic in our large series demonstrates the favorable results from the different biliary operation performed and invalidate the conclusions of Gegner who advises against any intervention upon the

biliary passages fearing the resulting disadvantages (Table I).

A study of the literature shows that 50 cases of invasion of the duct of Wirsung by ascarides had results similar to those in case with stone incarcerated in the papilla (Eberle Pfanner Gallie and Brown Rigby Sabrize Seyfarth).

In this connection I wish to report briefly a very rare case of acute pancreatic necrosis due to invasion of the pancreatic ducts by ascarides.

The case was operated upon with a tentative diagnosis of acute pancreatic necrosis 6 hours after the onset of excruciating pain uncontrollable and immediate shock. The entire pancreas was a blue color resembling a hemorrhagic infarct but fat necrosis had not yet occurred. The

TABLE I—OPERATIONS PERFORMED IN CASES OF ACUTE PANCREATIC NECROSIS IN WHICH THE BILIARY OPERATION WAS DONE AT THE SAME TIME

	R. P.	ed. P.	D. t.
Chl. y. t. t. my	5	6	44
Chl. d. h. t. my	60	0	4
Chl. y. t. t. my	64	36	0
mm. d. t.			
W. th. b. l. ry	6	3	38
W. th. t. b. l. ry	4	7	59
Chl. l. st. t. m.	49	4	5
Chl. d. h. o. e. t. t. my		8	6

TABLE II—PANCREATIC DISEASE AFTER OPERATION ON THE BILIARY SYSTEM

	C.
W. th. b. l. ry	4
W. th. p. d. d. l. h. l. l. tomy	9
W. th. t. d. d. l. h. l. d. o. ch. t. my	3
W. th. h. l. d. ch. t. t. m.	—
T. t. l.	8

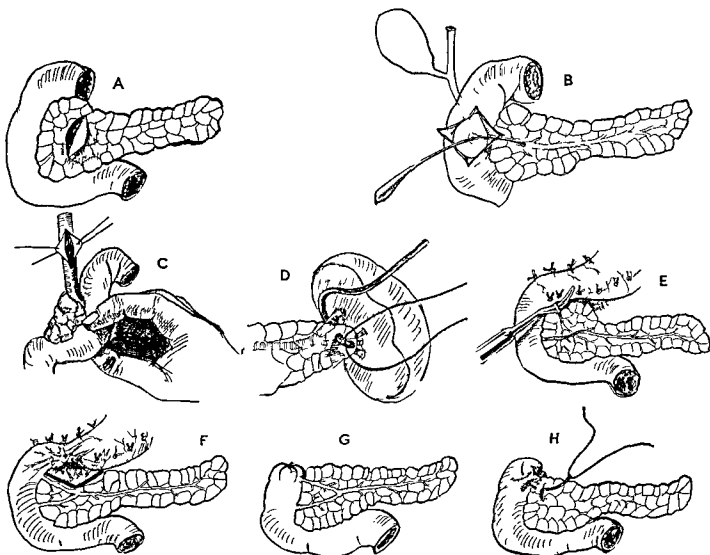


FIG. 8 Operative measures which can lead to acute pancreatic necrosis. A Diagnostic incision of pancreatic substance. B Slipping of sound toward the left and into the pancreatic duct in transduodenal choledochotomy. C The Hirschkern maneuver for pushing up gravel or stones with injury to the tail of the pancreas during division of the splenic vessel. D Tearing of the duct of

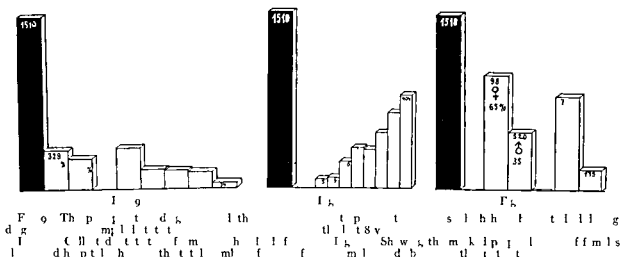
Santori during separation of the duodenum. E Sharp excision of a penetrating ulcer from the pancreatic substance. F Deep incision of the duodenal stump. G Coverage of the duodenal stump with the pancreatic head. H The sutures are too deep and therefore invade the pancreatic substance.

typical hemorrhagic exudate was present in the free peritoneal cavity but there were no stones in the biliary ducts. Death occurred 14 hours after the operation. The autopsy was done immediately and revealed extensive fat necrosis in the omentum and mesentery which had not been seen during the operation. Hemorrhagic infiltration of the entire pancreas with tiny microscopic areas of necrosis, a single ascaris was found in the duct of Wirsung, its head reaching to the tail of the pancreas and its tail protruding 1 centimeter into the lumen of the common duct. It was still alive and mobile when the ducts were opened. There were no other worms in the entire gastro intestinal tract.

Next to stasis of secretion and its activation the tissue damage secondary to the

violent penetration by the worm was an important factor in the production of acute pancreatic necrosis. This case is an example of its traumatic genesis and the extremely varied forms of postoperative pancreatic necrosis.

There is no doubt today that an operative trauma which injures tissues should receive great attention. We will later point out a large number of measures such as *thia artis* which have been considered harmless but which we would advise the careful surgeon to avoid. The pancreas should always be considered a labile organ which can be readily injured at operation.



The futility of many half hearted operative procedures was demonstrated in a number of discouraging cases. Even the blunt trauma which follows retroduodenal palpation of the common duct or incision for stones which may result in the pushing up of the stones and the so called Kirschnermanoever which is generally used may lead to fatal complication. Pancreatic necrosis may follow the closure of the suture knot after a bougie has been passed through the ampulla of Vater (Rost). At one of the last surgical congresses Walzel demonstrated the danger which may follow the use of a sound in transduodenal choledochotomy if the pancreatic ducts are accidentally invaded. He warns especially against this immediately before the transduodenal removal of a stone in the ampulla (Table II).

TABLE III—PANCREATIC DISEASE  
FOLLOWING OPERATION

Aft t m h p t	9
Aft bl y pe t	38
Aft pl t my	7
Aft d t	4
Aft th p t	5
T t l	45
T p f p	58
T d	5
A t p	8
P r u l t p	3
P t b	4
P t t t l	—
F t	—
th t y	—
i t p	—
t h g	—
T t l	—

An acute pancreatic necrosis may follow the blunt trauma occurring during gall bladder operation and also the intentional or accidental damage to the gland or neighboring organs during operation after diagnostic biopsy after suture of the pancreas to the duodenal stump in a Billroth II operation after puncture secondary to excision of the base of ulcers (Charmont) after the slightest damage to the tail of the pancreas secondary to splenectomy (Inziz Walzel Koerte) or during the ligation of the right kidney pedicle (Young) (Fig 8).

These graver complications do not always occur and as a general rule only those are recognized which terminate fatally. Instead of acute pancreatitis a purulent pancreatitis abscess formation or a pancreatic fistula with only a temporary disturbance of function may result (Table III). Charmont has demonstrated lung complications in connection

TABLE IV—STOMACH OPERATIONS LEADING  
TO PANCREATIC DISEASE

F	f p	t t	l	C
M bl t	f th	du d	m	7
l	f th	d o d	l t m p	6
l t	f th	d e t	f S t	—
I t	f p	t t	d d l y t m h	—
S t	l t	f bl d	p c t	8
C r i	f th	d o d	l t m p b y h d f p	6
G t	t t	t my	—	—
T t a l	—	—	—	91

with pancreatic trauma. Fifteen per cent of all cases of duodenal resection develop serous pleurisy which however disappears in 3 to 4 days. It is unfair to assume that all these operations were poorly done. Many surgeons adopt every precaution but one generally accepted warning must be mentioned here namely a reference to a generally rare but grave danger.

When the pancreas has been involved in the operation it is certainly not advisable to close the peritoneal cavity without drainage. This measure affords at least some measure of protection.

Stomach and duodenal operations supply quite a different group of pancreatic complications (Clairmont Table IV) peritonitis may follow suture line leakage which is secondary to the digestion of the technically perfect sutures by the pancreatic enzyme which arises from an unrecognized injury to the pancreatic veins. The mobilization of the duodenum supplies the source of blunt trauma which injures the parenchyma of the pancreas. Excision of the ulcer and faulty handling of the duodenal stump have already been mentioned.

Partial resection of the gland may be done for advanced cancer of the pancreas. This was recommended by Finsterer contrary to the existent knowledge of the high incidence of pancreatic necrosis and peritonitis. Von Mikulicz figured that this operation elevated the mortality from 27 to 70 per cent but to day the danger does not appear so great. Because of the same high mortality associated with pancreatic resection for other cause progress seems to be at a halt in this field of surgery.

Anomalies of the ducts supply a separate chapter. It is frequently possible without any danger to mobilize the duodenum and separate it from the pancreas as far as the ampulla of Vater. This procedure becomes hazardous when there is a possibility of impinging upon the duct of Santorini and its ligation is of importance. This was demonstrated by the work which Enderlen suggested to von Schwarz. This research demonstrated upon an embryological basis two forms of pancreas namely a tongue and a hammer type the lat-

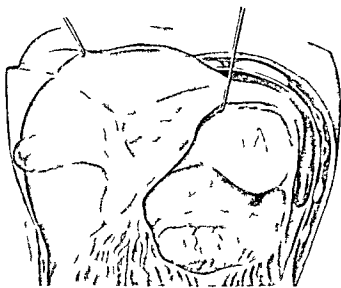


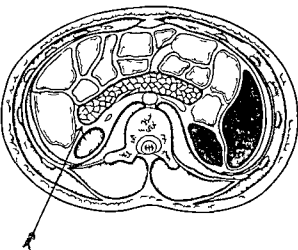
Fig. 1. Transperitoneal exposure of the pancreas through cutting of the gallotocolic ligament.

ter usually associated with a large and actively functioning duct of Santorini.

In spite of this the duct of Wirsung may be of importance and there is a definite danger of its being ligated in case requiring extensive separation. The following conclusions are justifiable from Schwarz's research. There is great danger of ligating the duct and obstructing its drainage in one fourth of all cases in which the pars duodeni is freed. A large duct of Santorini draining an important part of the gland should be feared when the pancreas is firmly fixed to the duodenum or the head of the pancreas is very large (occasionally reaching to the pylorus) the tongue shaped type of pancreas is generally associated with less danger.

The possibilities should be considered and avoided in every pyloric resection which approaches the pancreas. Regurgitation into the duodenal loop should also be avoided because of the danger of associated regurgitation into the pancreatic ducts. In addition care should be taken to keep the duodenal stump which has been inverted into the retroperitoneal space after a Billroth II from pressing too firmly upon the unprotected pancreas.

This chapter still contains many important unanswered questions for the practical surgeon. There is a possibility that the real cause of danger is not yet understood despite consideration of the separate role played by

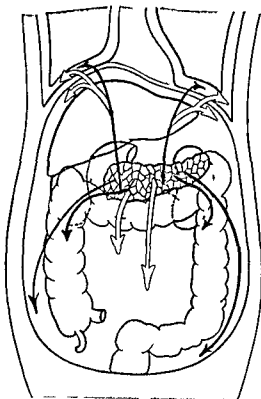


1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

each type of anatomical anomaly together with the elimination of danger involved in surgical procedures. We may call this a predisposition to pancreatitis a condition readily understood when we consider that in a biopsy will lead to fatal complications while in 99 other cases there will be an uneventful convalescence.

Guleks experiments have demonstrated that there is a marked significance in the phase of secretion but that there is still a predisposition to pancreatic involvement or perhaps a constitutional predisposition such as exist in the alcoholic, adipose or luetic. Perhaps we are right when we consider the sudden onset of this condition as the cumulative effect of all the etiological danger factors. It must be our goal to give this line of etiological reasoning our intensive study.

A consideration of those etiological factors which may damage the pancreas because of an imperfect blood supply indicate that they may include nutrition of the gland due to impaired circulation secondary to spasm, thrombosis, embolism, arteriosclerosis or to lues. Postoperative pancreatic necrosis secondary to retrograde emboli belongs in this category (Jenckel Orthner) and may follow any operation in the peritoneal cavity occurring either without manipulation of the pancreas (resection of bowel, omentum or ovary) or when the operative field is distant from the pancreas (proctectomy or operation for vari-



1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

cose veins). It may follow intoxication through the blood stream either in cases of severe poisoning from lysol, oxalic acid, meat or sausage poison or as frequently happens after septic processes such as puerperal sepsis, typhus, measles, otitis, otomyelitis or parotitis. Here again we are impressed with the fact that only certain individuals of an entire group who are affected with the same disease actually develop this complication. We know no causative factors for its development and moreover we do not know why after the introduction of the same septic process in several individuals one patient will develop an acute pancreatic necrosis with its stormy course and another will develop a purulent pancreatitis which behaves as might a pyemic abscess were it located elsewhere. The resistance of the individual and development of immunity together with the local and bacterial conditions naturally have a definite consideration in the prognosis (Zoeppfel Brutt).

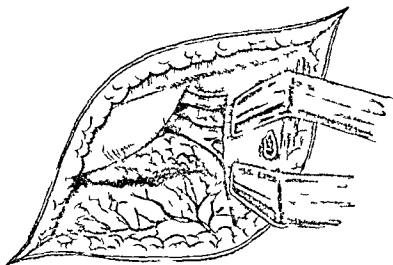


FIG. 15 Exposure of the pancreas through a left lumbar incision and median traction of the kidney. The spleen is visible on the left border of the incision. The splenic artery and vein cross the pancreas which is posterior.

The chapter on bacteriology is purposely slighted because at present it is not possible to evaluate the significance of infection in the development of acute pancreatic necrosis. The material here analyzed was compiled from a questionnaire and did not consist of consecutive cases so that no basis for positive conclusions was afforded (Table V).

Our own findings are based upon 10 cases. Bile from the gall bladder and common duct and the peritoneal exudate was found sterile in 9 cases. Streptococci were found in the bile and the peritoneal cavity in 1 case but may have been due to a secondary infection inasmuch as they were found 10 days after the onset of the disease.

We will only mention the frequently discussed symptoms and satisfy ourselves with a classified grouping of the clinical manifestations. Pain of the most excruciating type is nearly always present and is an important symptom. After very mild colic like prodromal pains (warnings which may be absent) an apoplectic attack of pain and collapse suddenly develop. These may be the result of intoxication from the pancreatic enzyme which lies free in the peritoneal cavity, the distention of the gland capsule, infiltration of the mesocolon or pressure upon the celiac plexus or upon the semilunar ganglion

(celiac neuralgia). The persistence of the pain until shock develops differentiates it from biliary colic. The pain diffuses backward from the left abdominal region to the lumbar region radiating to the left shoulder. The pulse is at first slow and small and later as a result of vagus irritation becomes still slower. Abdominal rigidity and distention are early signs but there is even at this time little distention and rigidity as contrasted to that occurring in ileus or peritonitis. The temperature is normal or subnormal, there is agonizing belching and vomiting while occasionally the pancreas can be palpated as a transverse ridge (Koerte).

Recognition of the disease at this stage requires a previous suspicion of the diagnosis. The observant general practitioner will recognize cases of peritonitis without temperature or abdominal rigidity. The following symptoms are certainly suggestive: cyanosis of the face, hands and extremities or as described by Walzel, blotches and latices like streaks of dark cyanotic color, upper abdominal distention, tachycardia 100 to 140, slight icterus, persistent emesis, absence of bowel movements or flatus, glycosuria and fatty stool. Melæna and emesis are rare symptoms as are oliguria and anuria which indicate kidney damage. Systemic intoxication causing



TABLE V — BACTERIOLOGICAL FINDINGS IN ACUTE PANCREATIC NECROSIS RESULTS IN TWO HUNDRED AND EIGHTY TWO EXAMINATIONS

C				C			
I	t	I	t	B	I		
St	t		84	St	I		4
I	t		3				54
B	ll	I	4	B	ll	I	6
St	phyl		34	St	phyl		
St	pt		37	St	pt		I
I	k l	I		m	J	f	t
ll							
I	t	pl	I				
ll		lm	I				
f	t						4

cramps and psychic disturbance have been observed. Death result from cardiac failure and the symptom complex of paralytic ileus cloud all earlier abdominal symptom.

In contrast to the rarer general picture there is still lacking a modern aid for making the exact diagnosis in the numerous atypical cases. Even today we must manage without a pathognomonic test which would make the diagnosis positive and which Koerte longed for in 1911. Wohlgemuth's diastase test in which the ferment is easily demonstrated in the urine and blood is of some value. It should be critically considered even when carefully done for even then the failure run about 20 per cent (Table VI).

In most instances one should rely upon the most probable diagnosis and differentiate between gall bladder perforation, stomach and duodenal perforation, gangrenous appendicitis, peritonitis of unknown etiology, ileus, me enteric thrombosis and ureteral colic. Our compiled statistics show that a positive diagnosis of acute pancreatic necrosis was made in only 18 per cent (Fig. 9) of the cases and suspected in 17.5 per cent. Therefore the pancreas was considered only in little less than 40 per cent of the cases.

The most common source of error in our series was acute cholecystitis which occurred in 95 per cent. This is readily understood as the patient early in the disease creates the impression of this diagnosis by giving a history of repeated similar transient attacks from which he completely recovered. On the other hand this is a fatal diagnosis for the physician becomes satisfied with the diagnosis

TABLE VI — DIASTASE RESULTS IN THE URINE IN NINETY SEVEN CASES OF ACUTE PANCREATIC NECROSIS AS DETERMINED BY TWENTY ONE DIFFERENT EXAMINERS\*

TRENCHES DIFFERENT FIXATIONS										C			
I		I	t							75			
N	I	t		(	p	r	t	)		9			
N	m	t		m	f	es	I	6	m	f	d	I	t

of gall tone, orders morphine and resorts to surgical intervention only when the pain is found to persist and the patient's condition is much worse. The influence of the biliary history together with the existing icterus and absence of temperature cause further delay in the case in which there are no marked signs of peritoneal irritation. When the condition becomes advanced a preoperative diagnosis of phlegmonous cholecystitis or perforation of the gall bladder is first made and then the patient is prepared for operation.

Even today we do not give enough attention to Koerte's old warning to consider acute pancreatic necrosis in all cases developing acute abdominal diseases especially when biliary colic has been evidenced. The recognition of the close genetic connection between cholelithiasis and pancreatic necrosis should cause the general practitioner to suspect implication of the pancreas especially in the presence of an unusually severe protracted colic in which the pain radiates toward the left and one dose of morphine does not give relief. A gall bladder history should afford the possibility of an early diagnosis.

Today the surgeon sees acute pancreatic necrosis quite frequently. Thirty-eight cases were operated upon in the last 8 years and in the same time there were 63 cases of gastric perforation—nearly twice as many! In 1903 Mikulicz reported 75 cases collected from the literature in 1911 Koerte collected 103 cases. In 1914 Guleke reported a compilation of 437 cases. Our questionnaire which was limited to postwar cases afforded 1510 cases. These statistics together with the simultaneous solution of many individual problems afford a reliable perspective of the position which is held at the present time by pancreatic surgery.

TABLE VII—THE OPERATIVE DETERMINED DEGREE OF PANCREATIC PATHOLOGY AND THE CURES FOR THE VARIOUS STAGES<sup>1</sup>

	Cured	Deceased
	Per cent	Per cent
92 Edema without fat necrosis	76.3	23.7
354 Edema with fat necrosis	62.5	60.1
251 Hemorrhagic infarct	36.1	56.0
193 Necrosis and areas of softening	43.0	68.0
34 Squestration	32.1	63.9
76 Abscess formation	39.9	37.5
Averages	48.8	51

Th. f. es. th. fir. t. c. l. m. g. th. pe. t. g. f. f. th. respect

There is a considerable increase in the number of cases occurring each year. This is especially noteworthy when compared with the well known observation by Wilms of a decrease during the years of the war. We do not believe that this increased frequency is secondary either to overeating, alcoholism, or other predisposing etiological factors, but we believe that it is due to the modern viewpoint of operating upon all acute abdominal conditions as early as possible. Our statistics show a marked preponderance of 797 plethoric individuals in contrast with 115 of an asthenic type.

The heretofore generally accepted opinion that males are commonly affected is in no way substantiated by our statistics (Fig. 11) which show 980 women and 50 men. This preponderance is readily explained by the greater incidence of cholelithiasis in women.

That this disease may occur at any age was demonstrated by the fact that in our series there were 10 children. Of significance was the coincidental presence of biliary disease in 4 of the 10 cases. Stones were found in 3 young girls 10, 11, and 15 years old and there was a bacillus coli infection in a 6 year old girl. Unfortunately the other cases gave no etiological factor.

Of the 1510 cases 178 were operated upon. There were 232 cases not operated upon in 149 cases the patients were already moribund and in 83 cases recovery was spontaneous because of the mildness of the condition. Only those cases in which operation definitely established the diagnosis should be discussed here. Because of the fundamental nature and course of the disease the diagnosis must al-

TABLE VIII—COMPLICATIONS FOLLOWING ACUTE PANCREATIC NECROSIS

	C
Diabet. (3 d. with in com.)	18
Chronic pancreatitis	6
Recurrent (6 occurring within 2 months after operation)	6
With a so. rted treatment of the biliary ducts	7
With treatment of pancreas only	19
1 e operation (10 cured 7 died)	17
Cyst formation	4
Peri tent fistula	5
Adhesions	3

ways remain doubtful in the cases not operated upon.

On the other hand there is no doubt that occasional cases of acute pancreatic necrosis may heal spontaneously when the process is favorable and the changes limited. Such cases of spontaneous healing are repeatedly reported in the literature. We ourselves have unexpectedly found residual evidence of pancreatic necrosis in 3 cases operated upon for cholelithiasis. These findings consisted of encapsulated areas of non irritating fat necrosis located in the mesentery and omentum and on the pancreas. Despite the fact that the acute stages of the intoxication may be survived by conservative treatment there occur such complications as areas of softening, pseudocyst formation or burrowing of pus which generally necessitate surgical intervention at a latter period.

#### INDICATIONS AND BEST TIME FOR OPERATION

The question of the indications and best time for operation is comparatively easy to answer inasmuch as every classic case is operated upon as soon as possible. However it is possible neither to predetermine nor to establish therapeutically which case will be severe. The advice derived from experience is to operate upon all doubtful cases. The fact that a patient may have successfully recovered from numerous similar prodromal attacks is not a contra indication to operation. Our experience has shown that cases without premonitory symptoms are the most grave. The firmly established fact that 95 per cent of the cases not operated upon die is sufficient indication of the gravity of the prognosis. Furthermore it is not possible to judge the



TABLE VI—PANCREATIC STONES IN TWENTY CASES

Symptoms	Cases	Cases
Clinical		Operative removal (all cured)
Jaundice	3	11
Colic	3	Found at autopsy 8
Ulcer	6	Changes of the pancreas
Diabetes	2	Cystic 4
X-ray		Sclerotic 9
Stone shadow	2	Acute necrotic 3
Intragastric tumor	1	Carcinomatous 1
Stomach cancer	1	Fatty 1

tum from the transverse colon (Stein) and (5) by Kocher's method of mobilizing the duodenum for unusual exposure of the head of the pancreas

Koerte was also familiar with the left sided approach from the lumbar region (Fig 13) to the tail of the pancreas and the right sided lumbar approach to the head of the pancreas and finally the transpleural way through the dome of the diaphragm

It is generally the rule that only the most experienced can give a prognosis even from the condition of the exposed organ. Cases having a limited local reaction are the most favorable. Exposing the gland is insufficient; surgical interference must be radical.

The peritoneal covering and the pancreatic capsule always should be split as far as possible. In this way the retropancreatic space is made accessible to drainage. The swollen organ is palpated for induration, areas of necrosis and finally for stones. It is advisable at this point to incise the gland substance avoiding injury to the ducts. Large areas of liquefaction necrosis are best opened bluntly by the finger. The majority of authors do not believe that axiomatic splitting of the capsule is advisable in every case. Tamponing will frequently stop the bleeding from blood vessel erosions, but this complication makes the prognosis less favorable. Hemostatic suture ligatures are in general to be avoided because here one operates in chemically eroded tissue.

The greatest care should be used in walling off the pancreas from the neighboring structures and in establishing drainage. The tampon and drains must be placed so that they do not favor retention of secondary secretion and can be left in from 6 to 8 days.

TABLE VII—PANCREATIC INJURIES TOTAL OF SIXTY TWO CASES—THIRTY CURED THIRTY TWO DIED

	Cases
Blunt trauma	31
Gunshot injuries	26
Stab wound	5
Injuries to the pancreas alone (14 cured 6 died)	20
Transverse rupture (6 cured 4 died 3 died with in 4 hr after injury 1 was operated upon and died 10 days after operation)	14
Gunshot injuries (cured 1 died)	3
Pressure injuries (2 cured)	
Fragmentation (1 died)	1
Complicated pancreatic injury (16 cured 26 died)	42
Organs injured at the same time	
Stomach	19
Liver	13
Spleen	7
Bowel	8
Kidney	
Aorta	1
Vena cava	1
Gall bladder	1
Common duct	1
Diaphragm	1
Lung	1

The regional fat necrosis is undisturbed. The peritoneal exudate which may be either serous or purulent should be handled as in any other case of peritonitis. It should be removed from every part of the peritoneal cavity either by sponging or by irrigation, thus eliminating one source of toxic absorption.

Finally it is necessary to guard against the characteristic downward seepage of pus which is associated with the pancreatic pathology (Fig 14). Occasionally in the primary operation it is necessary to provide counter drainage in the lumbar region. From our own experience we know that such drainage is easily instituted in the first operation. It often becomes very difficult in the later stages of postoperative handling because of the extensive adhesions, one becomes uncertain and fears meeting the retroperitoneal and other vessels. This becomes self evident when the anatomy involved in left sided exposure is considered (Fig 15). When there is a well walled off abscess in the advanced stages of this disease it is possible to consider only the lumbar method as primary.

A decision as to the operation of choice is most difficult to make and it is of vital importance that the entire surgical procedure be suitable to the patient's resistance.

We have already mentioned the proper procedure when there is associated biliary duct pathology. The biliary operation is done last just before the abdomen is closed and here again emphasis is placed upon a minute examination of the biliary ducts in every case. The reverse also holds true and in every operation for cholelithiasis the pancreas also should be minutely examined.

The cases of acute cholecystitis which we have operated upon usually have circumscribed peripancreatic edema limited to the head of the pancreas. This must be carefully looked for because it represents the first stage of an invasive process from the gall bladder and there is as yet no fat necrosis or serous exudate. The indicated therapy upon the biliary system causes the disappearance of the findings together with the described and brought to our attention by Zopf. Ample drainage and tamponade in the threatened area should be supplied. In this connection we are reminded of a case in which typical fat necrosis was found without any pancreatic changes. This without doubt was a case of spontaneous healing of pancreatic necrosis which had occurred in the previous few months.

However even though the peritoneal cavity be opened it is possible to overlook a case of acute pancreatic necrosis especially in exploratory laparotomies for doubtful acute abdominal disease. In such cases it is always necessary to think of the pancreas and to expose it as the fat necrosis may still be absent and the typical exudate be limited to the lesser omentum. Another source of error in diagnosis is which may cause the overlooking of acute pancreatic necrosis may be in a summing the incarceration of an associated hernia. The pain and the increased bulging of the hernia secondary to elevated intra-abdominal pressure suggest incarceration. However the hemorrhagic exudate is believed to be hernial fluid, the distended loops of bowel supporting the false diagnosis and primarily hiding the pathology.

What do we achieve by the surgical handling of acute pancreatic necrosis? Guleke's questionnaire in 1934 indicated a mortality of 5 per cent which is only slightly better than

the 60 per cent mortality reported by Koerte in 1911. We have reviewed 178 cases with a mortality of 63.4 or 51.2 per cent. This result is amazing! We had hoped that the mean result would be much better in a large new series of cases studied at a time when surgical intervention would be more efficient and when particular stress laid was being placed upon early operation. The figures of Table VII explain this very limited improvement.

These figures definitely demonstrate that an actual improvement can be achieved only when operation is performed in the stage before necrosis is present in a fully developed form. In this light we appreciate the idea of early operation and achieve its execution through organization of diagnosis. It is of prime importance that the general practitioner cooperate and at the proper time refer to the surgeon those cases in which there is the slightest suspicion of a beginning pancreatic necrosis.

The hope of receiving some aid from an immunizing agent has unfortunately not materialized. The well known experimental work of von Bergmann and Guleke and that more recently by the Japanese Ohno has been of no help (Harms).

Also there is slight prospect of securing an effective prophylactic immunizing agent in those cases in which there is great danger that the disease will develop.

As yet we are almost helpless in those cases which have already developed a systemic intoxication. In our clinic for many years we have used intravenous injection of glucose with insulin. We believe that it may favorably combat the intoxication and recommend its use not only preoperatively but also postoperatively for the first few days.

There are many serious dangers which still threaten the lives of the patients who survive the operation. Postoperative hemorrhage has already been mentioned. These are rarely stopped successfully by tamponade and usually result fatally. Late abscess formation and downward seepage of pus together with their course and treatment have already been mentioned. Finally there may occur empyema or numerous septic complications such as parotitis, pyelophlebitis or liver abscess.

The incision should be kept wide open for many weeks because of the persistent wound and pancreatic enzyme secretion and also because of the extremely long time required for the discharge of the gland sequestra. A temporary pancreatic fistula will naturally result with marked digestion of the tissue around the wound. It usually heals spontaneously after a varying interval of some times weeks or even months.

After the surgical wound treatment comes the selection of a diet which is low in fats and carbohydrates. In this manner due consideration is given to the impaired function of the pancreas which is spared every possible overtaxation.

What later course have those patients who pass through this severe disease? As yet we have no systematic postoperative histories from a large number of cases covering a protracted period. The late results of only occasional cases are available. From the results of the material operated upon in the Frankfort Clinic and from the literature we may conclude that the majority of cases which are successfully operated upon remain permanently cured. The health and life of a few patients can of course be endangered by the sequelae which may follow an acute pancreatic necrosis. These may be diabetes, chronic pancreatitis, recurrence, cyst formation, pancreatic fistula and adhesions (Table VIII). As yet we are merely listing the results and the essential features of the surgical interference derived from our questionnaire in chronic

pancreatitis (Table IX), pancreatic cysts (Table X), pancreatic stones (Table XI), injuries (Table XII).

#### CONCLUSIONS

1. Acute pancreatic necrosis is a disease of high mortality with varied pathogenesis and etiology. In the etiology diseases of the biliary tract are of the greatest significance. The genetic connection between bile duct diseases and acute pancreatic necrosis affords special consideration regarding diagnosis, therapy and prophylaxis.

2. The pancreas should be considered as an organ extremely susceptible to operative trauma and should be guarded against any possible damage especially during the course of operations upon the gall bladder, stomach and spleen.

3. A present day mortality of 51.2 per cent was found in our compiled statistics in 1,278 cases during the last 8 years.

4. Only in early operations is it possible to achieve the best results in acute pancreatic necrosis.

5. Systematic postoperative examinations of the patients who have been operated upon for acute pancreatic necrosis are necessary because of the large number of complications which may develop.

6. The results derived from the surgical treatment of chronic pancreatitis, pancreatic stones, pancreatic cysts and pancreatic injuries justify the hope for further progress in pancreatic surgery.

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6. The results derived from the surgical treatment of chronic pancreatitis, pancreatic stones, pancreatic cysts, and pancreatic injuries justify the hope for further progress in pancreatic surgery.



## UTEROSALPINGOGRAPHY

FURTHER STUDIES ON THE ACTION OF THE TUBAL SHUNCTOR A NEW SYRINGE FOR TRANS-  
UTERINE INJECTIONS AND A REPORT OF THE THERAPEUTIC USE OF IODIZED OILS  
WITHIN THE UTERUS AND FALLOPIAN TUBES

By JULIUS JARCHO M.D. F.A.C.S. N. Y. R.

A. J. C. C. I. T. I. O. I. Sy. h. m. H. I. A. I. C. I. H. I. H. B. h. d. H. I. d. H. m. I. D. h.

IN a previous communication published in a recent issue of SURGERY GYNECOLOGY AND OBSTETRICS (18) I reported a survey of the literature on the use of iodized oils for diagnostic purposes with particular reference to uterosalpingography and also some original observations of my own. This work I believe establishes the value of the roentgenological visualization of the uterus and fallopian tubes after transuterine injection of iodized oil as a means of exact gynecological diagnosis in selected cases.

It is my belief that uterosalpingography not only supplements the insufflation of gas but frequently supplants it. In cases of sterility it not only informs us whether the tubes are patent or not but also localizes the site of occlusion. Properly performed the test outlines the uterus and various portions of the fallopian tubes with great distinctness.

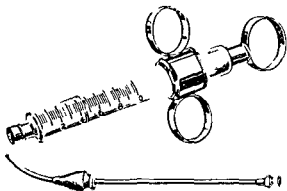
For a description of the technique of the method the reader is referred to my previous paper. The application of the test is quite simple but strict aseptic precautions must be taken. In my experience as in that of the

great majority of other workers the transuterine injection of iodized oil has been entirely harmless and I have observed no manifestations of iodism or other injurious reactions from its use.

Since my earlier paper was submitted for publication a number of important contributions on this subject have appeared. It is my purpose to mention the more important of these articles in order to make my review of the subject complete. More important however is the fact that I have observed striking therapeutic results after the use of iodized oils by transuterine injection. It is upon this phase of the subject that I propose to dwell most particularly. Furthermore brief mention will be made of the new syringe which I now use for the injections which has been improved by the addition of a manometer.

## RECENT BIBLIOGRAPHY

The reader is referred to my previous article for a bibliographical survey of the subject of uterosalpingography. Heuser (16) of Buenos Aires in 1905 was one of the first to employ iodized oils for gynecological diagnosis. However since Ferris' (10) article was published about the same time as Heuser's and Forester (11) states that Portier of France was the first to inject iodized oil into the uterine cavity for the purpose of roentgen ray study the matter of priority is rather confusing. Heuser injected iodized oil as a means of making an early diagnosis of pregnancy in women who had missed two or more periods. Roentgenograms taken subsequently showed the normal triangular outline of the uterus when pregnancy was not present otherwise the oil passed around the fetus and failed to fill the entire uterus. Heuser found that the injections were in no way injurious and did not induce abortion. On the contrary they were



I. J. C. C. I. T. I. O. I. Sy. h. m. H. I. A. I. C. I. H. I. H. B. h. d. H. I. d. H. m. I. D. h.



FIG. 1. Uterosalphin ogram of normal genital organs. *A* triangular shadow of the uterine cavity *B* beginning of the ampulla *C* isthmus of the tube *D* nozzle and tip used for introducing oil into the uterus *E* snare like compression of the tubal sphincter *F* free iodized oil in the peritoneal cavity

ineffective when attempts were made to produce therapeutic abortions thereby.

It was not long before the diagnostic possibilities of iodized oils were recognized and their injection was used for roentgenological visualization of defects in the uterus and fallopian tubes. This subject has already been covered in my previous paper and I shall merely add references to articles which have appeared since then.

Heuser (7) in 1926 added some important observations made with reference to a salpingo uterine sphincter action and the muscular contractions of the fallopian tube by means of uterosalpingography. Roentgenological pictures showed at the uterine cornu and in the cavity of the tube a space similar to the ring produced in the pylorus followed by the cavity of the tube in the shape of an ampulla. This ring is encountered in a state of relaxation or contraction according to the phase in which it is observed. It is observed in the terminal portion of the uterine cavity

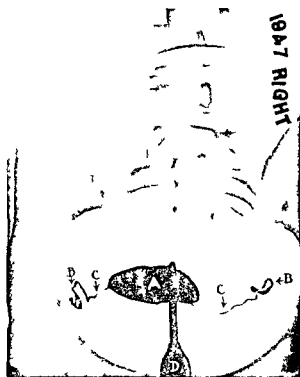


FIG. 3. Case 1. Roentgenogram showing free distribution of iodized oil throughout the peritoneal cavity 4 hours after the transuterine injection. Such picture may be obtained from all patients in whom the fallopian tube are patent.

thus explaining why the fluids of this cavity are not readily transported to the pelvic cavity. This constricted ring closes in some patients when the horn of the uterine cavity becomes contracted as seen by the shape of the walls in this region. This explains why in the presence of uterine hemorrhage the blood does not enter the peritoneal cavity but escapes through the uterine cavity. The sphincter which in roentgenograms is seen as a black line becomes displaced with the body of the uterine cavity itself on contracting without changing its place.

Heuser's findings not only show that the uterine cavity possesses a salpingo uterine sphincter and that the muscular contractions of the tube extend to the uterine cavity but also indicate the different roentgenological phases in the tubal cavity as follows:

1. The iodized oil in the peritoneal cavity is absorbed by the tube through capillary attraction and expelled into the uterine cavity through muscular contraction.

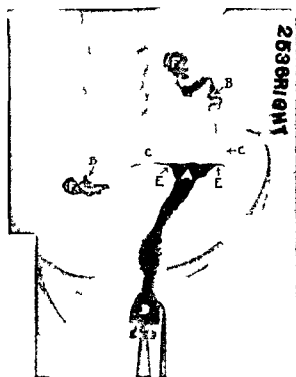


I 4 Sh p t fl f th t A tl t  
 l l th b f th mm t f th f l d  
 th l po t th h tl po t ll f th th  
 f th t l pl t f th l tt th  
 l h d f l

When there are remnant of placenta the salpingo uterine phincter remain open in some case thus accounting for ascending infection

3 Remnant of placenta in the uterine cavity produce in roentgenogram a deformity of the picture of the cavity because of the space occupied by the remnant in the uterine cavity thus explaining the deformity of the triangular picture of the uterine cavity when filled with iodized oil

On fluoroscopic examination of the uterine cavity filled with iodized oil one may observe when the cavity is occupied by some foreign body that muscular contractions occur as far as the neck of the uterus. They progress slowly sometime taking the form of undulations in the wall. In some case the contractions are energetic in other very slow. In patients with hyperthyroidism they take an energetic course. In those cases in which there are remnants of abortions fibromata etc or pregnancy the contractions are



I Sl lly l l  
 l pl l t ru d ght f ll p n t b t t l h h  
 th t l B th f th f ll p t bes h t b  
 p t t l l t f th l tt s th l h d  
 f l

very slow and in many cases they cannot be demonstrated

Bikke ( ) in 1917 by means of utero salpingography demonstrated the presence of a tubal sphincter not previously known. The tubes at the cornua are thickened in the shape of a funnel whose base is toward the uterus. This funnel is sharply defined from the uterine cavity just like the pylorus between the stomach and the duodenum. There is a snare formation seen in picture of all normal tubes which is undoubtedly produced by a sphincter. When the cornu sphincter and uterine end of the tube are enlarged the resemblance to the stomach pylorus and duodenum is still more striking. By histological examination Romcke (31) was able to demonstrate the anatomical substratum of this sphincteric action.

Jorchimovits (19) in 1906 found the injection of iodized oils entirely harmless and of undoubted value in the diagnosis and localization of submucous and intramural uterine



Fig. 6 The tubal sphincters F particularly the left are well shown. The tubes are patent and the oil flows freely into the peritoneal cavity. Note the large amount of iodized oil in the peritoneal cavity I although no symptoms were produced thereby. For an explanation of the letters see the legend for Figure

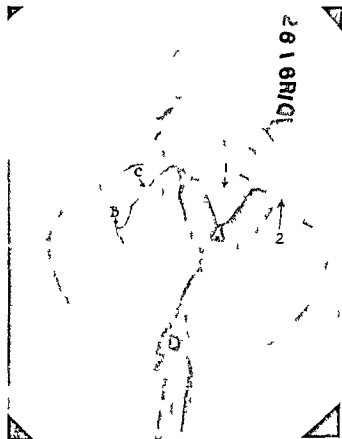


Fig. 14 In lent to n r p lue lly uterine fibroma and occlusion at the n n of th thmus. The occlusion of the r h t f llopian tub would have been overlooked had reliance been placed upon finding n the Rubin test. The condition shown here is frequently followed by placenta accreta.

myomata and also of intraligamentous tumors when combined with roentgenological visualization of the ureters. By taking the roentgenograms immediately after the injection with the patient lying down he found that contractions could be demonstrated in the normal uterus. This method of investigation makes it possible to diagnose infantilism, anteversion, retroversion and other deviations in the position of the uterus and uterine tumors also to demonstrate patency or occlusion of the fallopian tubes.

Cotte and Bertrand (8) in 1927 reproduced the illustrations presented with the article by Gregoire Beclere and Darbois (14) in 1926 which illustrate the value of iodized oil injections and roentgenography in the diagnosis of various pathological conditions. For the diagnosis of tubal patency it proved superior to insufflation and in the differential diagnosis of pelvic tumors for example between

myoma of the uterus and ovarian cysts the method was very serviceable.

Nalke (27) found uterosalpingography of special value in the diagnosis of tubal obstruction and the exact localization of the site of occlusion. He employed the method in 90 cases without admitting the patients to the hospital. For roentgenological visualization of the uterus and tubes he first uses insufflation of air and follows this procedure by the injection of a contrast material either sodium bromide or iodipin. Roentgenograms are made with the Bucky diaphragm. Equally good pictures were obtained with either contrast material and no untoward effects were observed.

Beclere (4) introduces lipiodol through a soft rubber tube with an olive shaped tip that fits the uterine cervix in each case. In order to avoid exercising too great pressure in introducing the lipiodol he has designed a



F 8 I d t t p d d by t t b m v m  
d ccl t t th b g g f th ht mp ll  
3 F l p nt m p t t t I pl  
t f th l t t th l d f I g

special uterine manometer that is attached to the syringe with which the injection is made. The injection is made under fluoroscopic control so that the iodized oil can be seen entering the tubes and if they are patent passing to the peritoneum. Beclere has used this method in more than 59 examinations and has found it of special value for the diagnosis of tubal obstruction and pelvic tumors.

Contrary to most investigators Odenthal (8) is of the opinion that uterosalpingography with various contrast materials cannot be regarded as an absolutely harmless procedure. He reports two cases in which pathological changes resulted from the injection of the contrast material. In one of these cases 4 cubic centimeters of 40 per cent iodipin was used. There was no immediate reaction the patient leaving the hospital 3 days after the examination and feeling entirely well but within 10 days she developed symptoms of peritoneal irritation with fever. After 3 weeks of treatment the symptoms subsided.



I q Sh m ll ft my m r the ht d  
h g po th t ty l l g p l  
l t d l my m n th left l l h f ll p n  
t l p t t l a pl at f the l t rs  
th l g d f I gu

On the basis of their clinical experience with roentgenological examination of the uterus and tubes after injection of lipiodol Grigoire Beclere and Darbois (15) in 1917 concluded that this procedure is practical harmless and of great value in diagnosis and as a guide to treatment. It shows the location form and volume of the uterus and the outline of the uterine cavity and any pedunculated or other growths on its walls. It further shows the outline and caliber of the fallopian tubes any obstruction and its exact location. Contra-indications to its use are acute infections with fever severe uterine hemorrhage and suspected pregnancy.

Grigoire Beclere and Darbois found that the differential diagnosis between uterine myomata and ovarian cysts which is sometimes difficult is simplified by the diagnostic use of iodized oil. In cases of metrorrhagia the method shows whether or not an intra-uterine tumor is present and indicates the best site for the removal of a section for biopsy.

Luettge (4) introduces 10 to 20 cubic centimeters of 10 per cent iodipin into the uterine cavity with minimal pressure. He does not induce preliminary pneumoperi-



FIG. 10. Showing displacement of the uterus to the right and posteriorly. The tubal sphincter is well defined. Both tubes are patent and there is free oil in the peritoneal cavity. For an explanation of the letters see the legend for Figure 2.

toneum. The roentgenograms are made immediately after the injection with a Bucky diaphragm. From his experience with this method Luetghe concludes that it is of definite value in gynecological diagnosis especially of tubal obstruction that it causes no inflammatory reaction and that it can be used outside of the hospital.

According to Randall (9) roentgenograms taken after the injection of iodized oils into the cavity of the uterus and fallopian tubes indicate a sharply limited field for salpingostomy in the treatment of sterility in women. He employed this method in 18 cases of closed oviducts at the Mayo Clinic. The roentgenograms indicate that in 6 of these cases one might expect success from operative treatment for sterility so far as the condition of the tubes was concerned. Two of these patients were operated upon and in each case the pre-operative diagnosis was confirmed. One of the patients subsequently became pregnant.

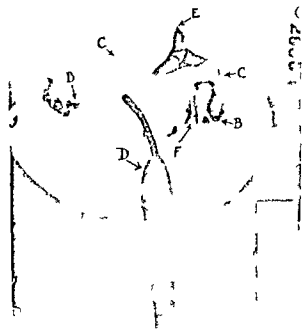


FIG. 11. Same conditions as in Figure 10, but from a different angle in order to show the distribution of the oil. For an explanation of the letters see the legend for Figure 2.

Steinhurter and Brown (10) found the introduction of iodized oil in roentgenography of value as an aid in the diagnosis of intrauterine conditions, mural fibroids, patency of the fallopian tube, the visualization of the size and position of the uterus, the recognition of early pregnancy, and in the differentiation between intrauterine and extrauterine tumors. They recommended it as an adjunct to the Rubin test and have found the injections to be entirely harmless.

Jungmann (11) made the roentgen-ray diagnosis of tubal pregnancy by filling the uterus in one case. The filling of the uterus showed a normal clearly outlined triangular area. There was no evidence of atony of the uterus which according to Dravoff is present in extrauterine pregnancy. Both tubes were completely patent. At the side of the questionable tumor the film-form picture of the tube showed an elliptical form. The abdominal end coincided with the angle of the tube in projection. Iodized oil had entered the peritoneal cavity through the abdominal ostium where it was visible as a flat shadow. At one point the tube was dilated to many times its normal diameter and showed a kidney-like shadow.



Γ h Sh dh e t t be Th mp ll ry  
p t f th ght f ll p t b dh t t th  
p t f f th ut Γ pl t f th  
l tt th l g d fo f g



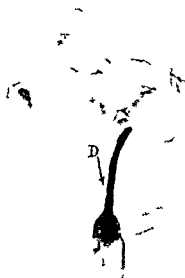
I 3 Sh d bl t th p h cy The  
ht d l t t tl m d the duz d l  
h l t l t d t lf bet th d l p l d  
th l l The fill g d f t th h d w p  
d l by th p f tl m The m ttd po t n  
d t th sc pe f l betw th ll f th d a  
b t N t l t th m tt ch d t th pt m  
b t th d bl t ru B c e of the poo ly d l  
p l d m t m lly f d h pta th cc  
h c f pl t cc t f l t A y little l  
h t l th l ft l d t ru th l tt h b t  
l l d g mm t lly D g amm t c tl f th  
t t t t d h d f l t l d a  
l d t l l 3 m 4 d d basal

This sudden alteration in the transverse section of the tube was attributed to the penetration of iodized oil into the space between the mucous membrane of the tube and the decidua capsularis. On the basis of this finding a diagnosis of extra uterine pregnancy was made and confirmed at operation.

In a study of uterosalpingography in 55 cases Reinberg and Arnstam (1 and 30) in 1936 found that whereas the normal uterine cavity is a symmetrical triangle the height of the triangle in the forward and backward displacement of the uterus is shortened with the result that it assumes a spindle or segmented form. With the fluoroscope and serial roentgenograms they observed movements of the uterus which they believed to be due to changes in the muscular tonus. In most cases they found that the uterus tends to expel the contrast material through the vagina by a sudden contraction of its walls. This muscular contraction may occur early or late but usually 15 to 20 minutes after the injection of the contrast material.

If the uterus empties itself early this same thing occurs when another attempt to introduce the contrast material is made and it is impossible to make a roentgenogram in such cases. There is in addition to this method of emptying the uterus a second method viz the gradual expulsion of the contrast material through the fallopian tubes into the peritoneal cavity. Peristaltic muscular contractions in the uterus could not be demonstrated with certainty.

Reinberg and Arnstam described a sphincter apparatus at the uterine end of the fallopian tube not previously recognized. Under normal circumstances it is capable of shutting off the uterine cavity from the lumen of the tube by a contraction of the annular muscle fibers in the pars interstitialis. The width of the zone of contraction varies from 1 to 15 millimeters. The closure is not always complete. By serial roentgenograms an active peristalsis of the walls of the fallopian tubes causing a rapid movement of the



2875 RIGHT

FIG. 14. Uterus bicornis. For an explanation of the letters see the legend for Figure

contents could be demonstrated. This movement was an antiperistalsis except in one instance in which a properistalsis was demonstrated in that the uterus after expulsion of its contents into the vagina was again filled from the fallopian tubes.

With regard to the clinical applications of uterosalpingography Reinberg and Arnstam found the measure of greatest value for the following purposes: (1) to demonstrate the patency of the fallopian tubes and localize any obstruction that may be present; (2) to differentiate uterine tumors, particularly submucous and intramural myomata; and (3) to diagnose early pregnancy which is shown by a filling defect and a rounder shape of the uterus due to atony. They never observed an abortion due to the injection of iodized oils and believe that its careful use is permissible in selected cases.

Nahmmacher (26) used uterosalpingography in 30 gynecological cases and was able to corroborate the accuracy of the procedure by the operative diagnoses. Contrasting with the triangular shape of the normal uterine shadow there is a clear space at the point of flexion in retroflexion. In metritis Nahmmacher found enlargement of the uterine



719 RIGHT

FIG. 15. Shows implantation of both tubes at the cornua. I and D are the letters see the legend for Figure

cavity and dilatation of the cervix. In uterine tumors there was a characteristic change in the shape and position of the uterine cavity. In ovarian tumors on the contrary the outline of the tube proved to be normal. Chronic adnexal inflammation showed its presence by dilatation and stricture of the tube and finally by displacement of the uterus. Like most other workers Nahmmacher considers uterosalpingography the best and safest means of demonstrating the fallopian tubes and he observed no injurious effects in any of his 30 cases.

Cotte and Pierre (9) found uterosalpingography superior to insufflation of the fallopian tubes for determining the cause of sterility, confirming the work of other investigators to the effect that this procedure not only demonstrates the presence of obstruction but also localizes the site of the occlusion. Furthermore it indicates the nature of the operative treatment required, that is salpingotomy, excision of the pavilion of the fallopian tube, resection of the isthmus with implantation



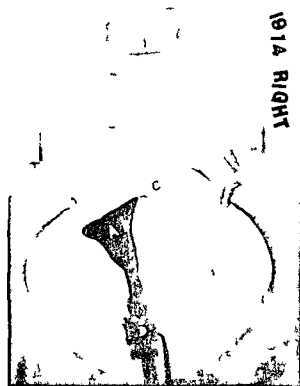


Fig. 6. Shows the uterus and fallopian tubes. The uterus is filled with iodized oil, and the fallopian tubes are also filled. The label '1914 RIGHT' is oriented vertically on the right side of the image.

into the uterus or—in cases of disease of the entire tube—transplantation of the ovary into the uterus. In the experience of Cotte and Pierre uterosalpingography proved especially useful for the differential diagnosis between hæmatosalpinx and ovarian cysts as a substitute for intra uterine exploration in cases of metrorrhagia for the diagnosis of malformations and hypoplasia of the uterus in dysmenorrhœa and amenorrhœa and particularly for the recognition and localization of tubal obstruction in cases of sterility.

#### THERAPEUTIC USE OF IODIZED OIL IN GYNECOLOGY

In my earlier work with iodized oil my object was only to obtain roentgenograms of the lumen of the uterus and fallopian tube for diagnostic purposes. By this means I was enabled to recognize normal fallopian tubes (Figs. 4, 5 and 6) occlusion of one tube

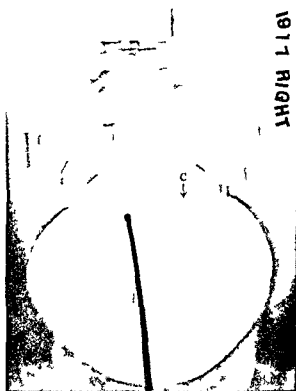


Fig. 7. Shows the uterus and fallopian tubes. The uterus is filled with iodized oil, and the fallopian tubes are also filled. The label '1911 RIGHT' is oriented vertically on the right side of the image.

only (Figs. 7 and 8) occlusion of both tubes (Fig. 15 and 16) encroachment on the uterine cavity by neoplasms (Figs. 7, 8 and 9) uterus bicornis (Fig. 14) and septate uterus with pregnancy (Fig. 13). In cases of occlusion moreover the exact site of the occlusion was determined (Figs. 7, 8, 15 and 16).

However I have been reluctant to inject iodized oil in cases of pregnancy. Although Heuser states that diagnostic injections do not interfere with normal pregnancy, I have been deterred not so much by fear of causing abortion as of doing possible injury to the offspring. In my own opinion uterography should be employed for the early diagnosis of pregnancy only when therapeutic abortion is contemplated and injury to the offspring is of no importance.



FIG. 18. Showing dilatation of the fallopian tubes with obstruction beyond the ampulla. The fallopian tubes are obstructed beyond the ampulla and are definitely abnormal. There is no free iodized oil in the peritoneal cavity. Twelve cubic centimeters of iodized oil were required to obtain this uterosalpingogram. For an explanation of the letters see the legend for Figure

Invariably before taking uterosalpingograms I gave my patients preliminary insufflations of oxygen or carbon dioxide if these measures had not already been employed. At the outset I had some misgivings lest the oil might cause injury to the peritoneum or abdominal viscera or transport infectious material from the fallopian tubes into the peritoneal cavity. Subsequent experience proved that these fears were not justified.

If the objections which have been mentioned were valid they would apply to an equal degree to the Rubin method. Yet even though the Rubin insufflations are widely used subsequent intra-abdominal complications are infrequent and practically all workers are now agreed that uterosalpingography may be employed with the same measure of safety.

At first I did not suspect that injections of iodized oil might have possible therapeutic value in gynecological conditions but I became interested in this possibility when I realized that the oil could enter the peritoneal

FIG. 19. The same patient as in Figure 18. The roentgenogram taken from the left side shows the position of the left fallopian tube.

cavity without causing injury. It was reasoned that since an oil emulsion containing liberating iodine could be injected to reach the peritoneal cavity without entailing serious consequence the use of the substance might possibly be attended with therapeutic advantages.

I was encouraged in my investigation of the therapeutic possibilities of iodized oil by the experience of H. M. Little, M.D., of the Montreal General Hospital, whose work I have quoted elsewhere. Little successfully used injections of 10 per cent spirits of turpentine in liquid paraffin in the treatment of infected fallopian tubes as follows: After laparotomy the pus if present was aspirated through a puncture in the wall of the tube and 1 to 3 cubic centimeters of the turpentine-paraffin mixture was slowly injected, the abdomen was then closed without drainage. After this treatment Little observed no untoward effects and some of the patients subsequently gave birth to healthy children. This procedure of course should be attempted only after acute symptoms of adnexal inflammation have subsided.

It is perfectly plausible that an iodine liberating preparation proved roentgenologically to enter the fallopian tubes after intra-uterine injection should give therapeutic results similar to those obtained by Little.



ft. j. t. Th. m. t. c. h. s. t. k. h. l. j.  
Th. k. tl. l. th. d. t. l. l. dl. t. ft. l.  
mp. ll. j. t. d. th. th. l. dl. v. l. t. t.  
f. th. d. l. f. m. th. f. ll. p. t. b. d. th. t. t. m.

In that event it would be obviously better to employ the treatment by this route rather than after laparotomy.

A survey of the literature on the therapeutic use of iodized oil yields very little information. Yet it will be recalled that lipiodol was originally used for therapeutic purpose being administered by intramuscular injection for the purpose of slow iodine medication. It was only when opaque spots were noticed on roentgenograms long after such injections that Sicard and Foretier (55) in 1911 applied it to roentgen ray diagnosis. In our enthusiasm for the diagnostic use of iodized oil we have largely forgotten its original therapeutic application. Peculiarly, however, Linker (111) has obtained excellent results in the treatment of surgical tuberculosis by intramuscular injections of sterilized peanut oil combined with a small quantity of tincture of iodine.

Sicard (3) remarks that lipiodol possesses noteworthy therapeutic properties. In his experience rheumatic pains are considerably improved by local injections the introduction of 5 to 10 cubic centimeters into the painful region sufficing. The injection should be deep preferably reaching the level of the

J. S. m. l. s. t. k. n. m. th.  
ft. t. t. t. l. g. phy. Th. p. t. p. t.  
l. t. t. l. m. B. t. f. ll. p. t. e. p. t.  
t. d. th. l. l. l. m. t. t. th. p. t. t. c. ty.  
th. h. th. t. l. l. m. l. C. mp. th. F. t.  
s. q. l. l. t. th. t. th. f. ll. p. t. l. l. t.  
l. f. m. p. t. t. f. t. h. l. k. d. th. m. l.  
f. t. l. j. l. t. f. th. l. t. th. leg. d.

bone. Sicard obtained excellent results with this therapy in sciatica. In lumbago sacral epural injections worked wonder. For the articular pains of arthritis periarticular and sometime intraarticular injections of lipiodol likewise proved of value.

Torto (7) believes that the subarachnoid injection of iodized oil is of value in the treatment of Lott's disease. Other than initial headache and paraesthesia in the lower limb he has observed no harm following this procedure. Torto is of the opinion that the direct iodine medication to the region of the diseased vertebrae should constitute ideal therapy and that the slow but continuous absorption of iodine in proximity to the lesion should be of distinct therapeutic value. However further investigation is required on this subject.

Graefinghoff (113) in 1917 reported the use of iodipin in a case of staphylococcus infection of the ventricle of the brain with suppuration. Six cubic centimeters of iodipin were injected into the right lateral ventricle which was markedly dilated. Several convulsions occurred immediately after the injection. The reaction was followed by definite improvement in the general condition a drop in the



FIG. 22 The same case as in Figure 1 after the oil has been allowed to drain off and a sound introduced to orient the position of the uterus. Compare this picture with Figure 20 from the same patient which shows tubal distention but no free oil in the peritoneal cavity. Lay off the injection. For an explanation of the lettering see the legend for Figure 1.



FIG. 23 A malleable uterine oil pump from which one would be able to see that the left fallopian tube was occluded. Compare this figure with Figure 24. For an explanation of the lettering see the legend for Figure 2. The iodized oil shows the uterus to be of normal size. The right cornu is slightly displaced to the right of the cervix to the left. The right fallopian tube is filled with iodized oil throughout its entire length. The left tube is not shown. Note that there is a well defined pincher at the right cornu.

temperature again in weight and reduction in the number of convulsions. The improvement continued for 2 weeks but after that period the child grew worse and died 5 days after the iodipin injection. Autopsy showed nearly 4 of the 6 cubic centimeters of iodipin injected still in the ventricle. The other ventricle showed inflammation of the walls which were covered with a thick suppurative exudate. The walls of the right lateral ventricle were smooth and normal. This change in the right ventricle Graevinghoff attributed to the action of the iodipin.

In one case of hemorrhagic tuberculous pericarditis Castex (5) performed a therapeutic pneumopericardium. As the roentgen ray appearance suggested the presence of adhesions 20 cubic centimeters of lipiodol was introduced after the withdrawal of 100 cubic centimeters of exudate. The roentgen ray examination after this injection showed no evidence of adhesions. The lipiodol penetrated into the meshes of the inflamed tissue of the pericardium and remained there. Repeated injections were given at intervals of 5 to 14 days but they had no definite influence on the pathological changes in the pericardium the disease running the usual

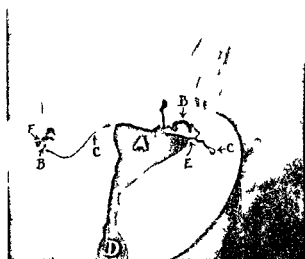
course. Injections were well tolerated. There was little or no absorption of lipiodol as was demonstrated roentgenologically.

Many years ago McShane (25) injected oil of sesame into the trachea and bronchi for therapeutic purposes. Jones and Jamison (17) believe that slow liberation of iodine following the injection of iodized oils into the bronchi exerts a distinctly antiseptic influence and that iodized oils are therefore of value in the treatment of lung abscess, bronchiectasis and chronic bronchitis. Brillon and Brillon (3) note that iodized oils are beneficial in the treatment of bronchiectasis lessening the cough and diminishing expectoration.

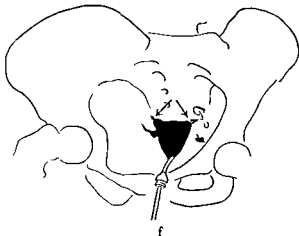
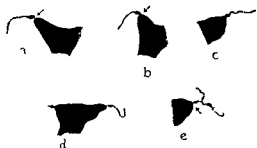
Cotte and Bertrand (6) in 1906 were perhaps the first to suggest the therapeutic use of iodized oils in gynecology. They observed at that time that lipiodol has a powerful antiseptic action and would destroy any microorganisms in the fallopian tube after intra-



R



I 4 Th m a T 3 but t k f m  
l f t l / f l l p t l l l l l  
l l l h p l t h g h l t b d m l t  
th p t l t y T l p p t h t  
l t m l y l f t f l l p t b t l l y t l l  
Th p t l l t t h m p t f m k g p l t  
f m l f t l l l p l t f t h l t t  
th l l f f



T 5 Th c l l t b l p l t S k t h e s d r a  
f m p t t l p a a m t l l t a t t h c t  
f t h p l t t t h t ( T g 6 b F g  
T g 8 d I 5 I g 3 l 4 f T g )

uterine injection. Although they used lipiodol for diagnostic purposes in more than 5000 cases of acute or subacute inflammation of the fallopian tubes they never noted any rise in temperature or any unfavorable reaction due to the introduction of the oil. They therefore suggested that the injection of iodized oil might prove a useful therapeutic measure early in the course of salpingitis and that it might result in early recovery and prevent tubal obstruction.

Jorchimovits (19, 20) observed that in 2 cases of profuse leucorrhœa and 1 of non-gonorrhœal endometritis there was a marked diminution of the uterine discharge after 2 intra uterine injections of iodipin; the substance remaining in the uterine cavity for a considerable period.

Cotte and Fierre (9) gave intra uterine lipiodol injections in 10 cases of acute adnexal inflammation without harm. They believe that in certain conditions the iodized oil

may have a favorable influence on the pathological process in the fallopian tube.

Having in mind a possible therapeutic effect from the transuterine injection of iodized oils and also being reluctant to use force in cases of salpingitis on account of a possible danger of forcing septic material through the lubricated extremity, I have made it a practice to inject the oil slowly and with great care. Under my direction a Luer syringe with a manometer attachment is being perfected in order that the pressure may be readily determined. A pressure of 30 to 40 millimeters is sufficient and ordinarily the amount of material required to fill the uterus and fallopian tubes is 4 to 5 cubic centimeters. By a preliminary examination of the internal organs one can usually estimate the amount of oil required in a given case. Furthermore, since roentgenograms are made concomitantly, fluoroscopy may be used to gauge the amount required to fill the uterus and fallopian tubes without forcing excess into peritoneal cavity.

In several of my cases of quiescent or chronic salpingitis the iodized oil appeared to have pronounced therapeutic effect. The most striking results were obtained in Case 14 the details of which are given under the case reports. When the injection is being made for diagnostic purposes only it is not necessary to take the pressure.

It cannot be emphasized too frequently that if too much force is used in the injection a spasm may occur in the musculature of the uterus and the fallopian tubes as a result of which the patient experiences a sinking sensation or even sharp pain. Earlier in this article I have referred to the sphincteric action of the muscular bands at the uterine cornua commonly called the tubal sphincters and this function is exemplified by the finding shown in Figures 5, 6, 8, 10, 21, 3, 24 and 25. The existence of this sphincter furnishes the real reason why force should be avoided in the injection of iodized oil or the insufflation of gas. For one who has not required the sense of touch by which to gauge the amount of pressure being employed the use of a syringe with a manometer attachment has obvious advantages.

With regard to the application of the Rubin test one must bear in mind that the formation of a pneumoperitoneum during transuterine insufflations of gas does not give an absolute diagnosis concerning the permeability of the fallopian tubes. In Cases 5 and 6 insufflation was followed by all the evidences of free entrance of air into the peritoneal cavity. The mercury in the manometer rose only to 100 and 104 millimeters respectively and then dropped rapidly to 60. Shoulder pain was present and roentgenological examination established the presence of air in the peritoneal cavity. Yet the uterosalpingograms proved that only one tube was patent in each case.

In Case 8 high manometer readings reaching 210 millimeters were obtained during the insufflation of oxygen notwithstanding the fact that several attempts were made during the same sitting. Yet when iodized oil was injected the fallopian tubes opened up and showed the true condition to be not obstruction of the fallopian tubes but a shortening of

the right adnexa and a displacement of the uterus to the right causing a kink in the fallopian tube. In Cases 1 and 13 the insufflation readings were high without a secondary drop and it was the uterosalpingograms after the injection of iodized oil that located the occlusion which was at the cornual ends of the tubes.

I do not mean to belittle the value of the Rubin insufflation test for the fact that this diagnostic procedure has been widely utilized the world over is sufficient evidence of its usefulness but I do believe that uterosalpingograms taken after the transuterine injection of iodized oil give a more accurate and a more detailed picture of the pelvic lesion.

It is important to take several plates at different angles otherwise several shadows may be superimposed and thus lead to an error in diagnosis. In Figure 3 for example the left fallopian tube appears to be occluded but in reality it is hidden behind the uterine shadow as shown by Figure 24. It is advisable to take one picture after the oil has been allowed to drain off from the uterus. As some oil remains in the uterus and fallopian tubes for a time shadows of these organs will persist. On the other hand the persistent absence of a shadow of the fallopian tube in uterosalpingograms taken when the uterus and tubes are filled with oil and again after the oil has been allowed to drain off would indicate that the oil did not enter the tube and that it is therefore occluded. The latter condition is shown in Figures 16 and 17 which indicate that the left tube was entirely occluded while the right was only partially and incompletely filled.

In my investigation I employed lipiodol which is a chemical compound of poppy seed oil and iodine solution.

#### CASE REPORTS

**CASE 1.** Normal uterosalpingogram. B. C. aged 35 married 11 years complained of primary sterility. Pelvic examination revealed an anteverted but freely movable uterus of moderate size. The cervix was directed downward and forward. The introitus was normal. The adnexa appeared to be normal. The patient received a transuterine injection of 5 cubic centimeters of iodized oil after which the uterosalpingogram was taken. The result is shown in Figure 1 which may be taken as an illustration of

th normal g al g ns A roentgenogram taken 24 hou aft th i j ti n sho d the iod zed oil fr lv di tril ut i throughout the peritoneal ca ty (Fig 3)

CASE 3 Sh rp anteil xion of uterus L G ag 1 2 mar d 3 v a com pla ne l of primary sterility. O 1 l 1 amin ti n th ut rus as found to be harply int fl x l l t fr lv mo able The adnexa n t p l b l c Wh n oxygen i sufflations v re g n th pr r r i h l o o millimeter v outhout l p th u v Sev ral attempt c male to i r th gas thr gh but th v cre all uns ccs ful f ould bc i t r m n d Th e as no fall i t l r r l t t n as negati r e t g n o l g l v m n a t o n i n t h p cumop r t i o n c u m n l f t i t l i d n t m p l a i n of h u l l e r p a i n l h p t t r i l n j e c t i o n of 4 5 cubic tim t r f l z l i l f t r h c h s a l t g i g a m t l e Not i t h t a n l i n g t h l t f t h R u b n t t l t h f l l p a n t u b e r f u l t b p a t n t l t h e r a f c c i l o i l i n t h i t a l t v Th t v p l i c t u r of sharp t f l x n i h I g u r 4 Th s s t h t v p f h h t h D u l l v p a t i o n o n t h e c e r v i x m v f i t a r f t h s t r i l t

CASE 3 Al n e c o n i c l e v i v e t h e r i g h t f a l l o p i a n t l l g h i n t h l l S W a g 1 3 m a r r i e d 1 1 v a r m p l n l o f p r i v s t r i l i t y O n p e l v i c i t m t h u t u s a s f o n d t o b e f s m a l l i m h t d p l a d t t h r i g h t T h c e r v i a l n g a n l i l v i t h a p h l t r n l A f t r t h i j e c t i o n of 4 u b c n t i m e t e r s of l l i l t h u t r o s l p i g g r a m i l l y c o n f i r m l t h f n d g s o b t r u l o n m a n u l e x a m i t o n (Fig 5)

CASE 4 Marke l sph n t e r c t o n a t t h e u t e r n e c r u B B a g d 2 2 m a i d 2 3 y e a r s c m p l o f p i m a v s t e r i l i t y T h e u t e r o s a l p n g r a m w a s t a n a f t t h i n j e t o n o f 8 c u b i c e n t i m t s o f i l d l (Fig 6)

CASE 5 I n d e t a t i n p l u e l b y a u t e r i n e f b m a n d c l u s o n a t t h e b i n n i n g o f t h e i s t h m u s S L g d 3 1 m a e d 2 y e a r c o m p l a i n e d o f p r i m a r y t l t v H r m e n s t r a l p e i o l o c c u r r e d 3 3 e e k s a n d 1 s t e l 7 d a y s O n m a n u a l e x a m i n a t i o n t h u t r u s a s f o u n d t o b e a t e x i d e d a n d l i g h t l y e n l a r g e d T h r e t w o u t e r i n e f i b r o m y o m a t o n e b o r 5 c n t m e t e r s i n d a m e t e r a t t h e f u d u s t i m j o r p o r t o n a p p a e n t l y f o r m i g p a r t o f t h e u t e r i a l l t h o t h e r b o u t 3 c e n t m e t e r s i n l a m t e l c a t d u t t h i g h t c o r n u T w o d a y s p r i o r t o t h e i n j e c t i o n o f i l z d o i l t h e p a t i e n t a s n u f f i c i l w i t h v x n A s a s h o n b y a l l t h e s t a n d a d s g n s i n c l u d i g t h r e n t g n o g a m t h e g a s n t l t h p t n a l c a v i t y c a d i l y a n d g a v e n o i n l i a t o f t h e e i s t n e e o f b s t r i n a t t h e r i g h t c o r n u T h e u t e r s l p i n g a m o u t h i n d t h i n d n t a t i n p r o l u c l b y t h h b r m y o m a a t t h e f u n d s a n d i l h o e d t h a t t h e r i g h t i s t h m u s v a c c l u d e d (Fig 7) S h o l d t h p a t i e n t b e c o m e p g r a n t v e x p e c t t h e d e l o p m e n t o f p l e n t a r e t a s n c a f i b o m a s o l o c a t e l m a y

produce an atrophy of the overlying endometrium a condition which is often the forerunner of placenta accreta

CASE 6 Occlusion of the fallopian tube at the beginning of the ampulla R D aged 30 complained of primary sterility Menstruation occurred every 4 we ks as of 4 days duration painful and thmod rate flow On manual examination the uterus as found to be of moderate size and freely movable On the right side of the uterine isthmus a fibromyoma about 6 centimeters in diameter was palpated After insufflation with oxygen the pressure reached only 104 millim t r s a n l p p d r a p i d l y t o 60 m l l i m t r s I t v o u l d s m f r o m t h e s e f n l i n g t h t t h e t u b e w e r e p a t e n t B u t t h e u t e r o s a l p i n g r a m t a k n s t e r t h i n j e c t i o n o f i o d i z l o i l (Fig 8) showed the right fallopian tube to be occluded at the beginning of the ampulla and also indicated an area of pressure from the fibromyoma on the right side of the uterus

CASE 7 I n d e n u c l a t e d u t e r i n e f i b r o m y o m a e n c r o a c h i n g u p o n t h e u t e r i n e c a v i t y I S a g e d 20 m a r i e d 4 y e a r h a d h a d 2 s t i l l b i r t h a t t e r m R o n t g e n o l o g i c a l s t u d y a f t e r t h e i n j e c t i o n o f i o d i z d i l (Fig 9) showed both fallopian tubes to be patent with a small fibroma on the right side encroaching upon the uterine cavity The uterus as a larger pedunculated fibroma on the left side

CASE 8 D i p l a c m e n t o f t h e u t e r u s t o t h e r i g h t a n d p o t e r i o r l y d e f i n e d s p h n t e r a t t h e u t e r i n e c o r n u E A a g e d 3 4 m r i e d 6 y e a r s c o m p l a i n e d o f p r i a r y s t e r i l i t y S o o n a f t e r m a r r i a g e s h e w a s i l l f o r s a l v e k s w i t h p e l v i c i n f l a m m a t i o n I n s u f f l a t i o n w i t h o x y g e n r e s u l t e d i n a p r e s s u r e o f 10 millimeters and the res was no drop The presence of gas in the peritoneal cavity could not be demonstrated by a scultat on should r pain or roentgenogram After the transuterine injection of 6 cubic centimeters of iodized oil the uterosalpingograms (Fig 10 and 11) showed free oil in the peritoneal cavity p o v n g t h a t b o t h t u b e s w e r e p a t e n t T h e y a l o s h o e d t h e u t e r u s t o b m a r k l y d p l a c e d t o t h e g h t a n d b a c k w a r d i n t h e h o l l o w o f t h e c r u m T h e r e w a s a v e l l d e f n e d s p h n t e r i n t h e l f t u t e r i n e c o r n u

CASE 9 A m p u l l a r y p o r t i o n o f t h e t u b e d h e e n t t o t h e u t e r u s R L a g e d 3 1 m a r i e d 7 y e a r s g a v e a h i s t o r y o f h a v i n g h a d p e l v i c d i s e a s e s e v e r a l y e a r s p r e v i o u s l y O n m a n u a l e x a m i n a t i o n t h e u t e r u s a s f o u n d t o b e s o m e w h a t e n l a r g e d a n d t o b e c l e a r t o t h e r i g h t p l v i c a l l I n s u f f l a t i o n w i t h 1 20 c u b c c u m e t e r s o f x y g e n r e s u l t e d i n a p r e s s u r e o f 150 millimeters dropping to 10 millimeter The entrance of gas into the peritoneal cavity was confirmed by auscultation after shallow pan and pneumoperitoneum roentgenologically visualized Th uterosalpingogram (Fig 12) showed both fallopian tubes to be patent but the ampullary portion of the right tube was adherent to the posterior surface of the uterus

CASE 10 Double uterus ith pregnancy Mrs F 6 weeks pregnant was found on manual examination

to have a double uterus. The uterosalpingogram taken after the injection of iodized oil revealed the conditions graphically (Fig. 13).

CASE 11. Uterus bicornis. S. D. aged 35 married 5 years complained of primary sterility. After the injection of iodized oil the uterosalpingogram showed a uterus bicornis (Fig. 14).

CASE 12. Occlusion of both tubes at the cornua. C. E. aged 30 married 2 1/2 years complained of primary sterility. She had suffered formerly from profuse leucorrhoea. On manual examination the uterus was found to be of moderate size anteflexed and movable. The adnexa were thickened. After insufflation with oxygen there was no evidence that the gas had entered the peritoneal cavity. The uterosalpingogram taken after the injection of iodized oil (Fig. 15) showed occlusion of both fallopian tubes at the cornua.

CASE 13. Occlusion of one tube at the cornu. S. G. aged 29 married 6 years complained of primary sterility. Eighteen years previously she had had an operation for ruptured appendix 8 years previously one for intestinal obstruction. On manual examination the uterus was found to be moderate size anteflexed and sinistrotorted. The adnexa were not palpated. With oxygen insufflation the pressure reached 60 millimeters and there was no drop. After the injection of iodized oil the uterosalpingogram (Fig. 16) showed a uterine shadow of normal size but displaced to the left.

A small portion of the isthmus of the right fallopian tube was incompletely filled with the oil but the remainder was occluded. The left tube was occluded at the cornu. In order to remove any doubt that the left fallopian tube might be patent but hidden behind the shadow of the uterus a second uterosalpingogram was taken after the oil was allowed to drain from the uterus (Fig. 17). This picture likewise failed to reveal any shadow referable to the left fallopian tube.

CASE 14. Therapeutic effect of iodized oil. I have referred to this case in my previous paper in SURGERY, GYNECOLOGY AND OBSTETRICS but I am mentioning it again because I have subsequently observed a remarkable therapeutic effect following the injection. M. B. aged 34 had no children. She had had an abortion 11 years previously and was very ill at the time. Since then she had suffered from abdominal pain which was worse at the menstrual periods. Backache was severe. Pelvic examination revealed a retroposed uterus of moderate size. The fallopian tubes were thickened and readily palpable. There was more pronounced thickening at the distal portions giving the impression that the tubes were adherent to the lateral walls of the pelvis. The patient received an injection of iodized oil on February 8, 1917 and was subjected to roentgenological study. The roentgen ray findings are shown in Figures 18, 19 and 20.

In November 1917, 10 months after the first uterosalpingography another roentgenogram was taken after injection of iodized oil. A normal utero-

salpingogram was obtained (Fig. 1 and 2). Both fallopian tubes were patent and of normal contour and free iodized oil was seen to enter the peritoneal cavity. There was also a well defined sphincter at the uterine cornu on the right side. We cannot disregard the possibility that the injection of iodized oil 10 months previously was the essential factor in bringing about the restoration to normal conditions.

CASE 15. Misleading absence of a tubal shadow in uterosalpingogram. R. J. aged 29 married 9 years complained of primary sterility. Soon after marriage an abdominal operation had been performed for pelvic disease. Four insufflations had been performed within a period of years without obtaining entry of the gas into the peritoneal cavity. After a hysterosalpingogram had been injected the uterosalpingogram seemed to show occlusion of the left fallopian tube (Fig. 3) but when an exposure was made from a different angle (Fig. 4) it was apparent that the left fallopian tube was not occluded but merely concealed behind the shadow of the uterus. The findings in this case emphasize the importance of making plate from different angles.

#### SUMMARY

1. The consensus of opinion of the great majority of investigators who have employed iodized oils for roentgenological visualization of the female genital organs is that the procedure is entirely safe and harmless and a most valuable addition to our equipment for making gynecological diagnoses. In my experience it not only supplements but frequently supplants insufflation of gases.

2. Uterosalpingography gives us a vivid picture of the conditions existing within the female genital tract.

3. The most valuable use of uterosalpingography is for the recognition of occlusion of the fallopian tubes and the localization of the site of the obstruction.

4. In many gynecological disturbances uterosalpingography gives us exact information that can be obtained by no other means.

5. There is a definite sphincteric action at the uterine cornu sometimes called the tubal sphincter.

6. My experience leads me to believe that the transuterine injection of iodized oil may have definite therapeutic advantages in subacute and chronic conditions of the fallopian tubes.

7. A case is described in which uterosalpingography revealed dilatation and occlusion of both fallopian tubes but in which a



second uterosalpingography 10 months later gave an entirely normal picture. There is reason to believe that in this case the slow liberation of iodine within the fallopian tubes had a pronounced therapeutic effect.

A new syringe equipped with a manometer and specially adapted to the trans uterine injection of iodized oil is described.

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m l d d d l s C d M A J  
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d l d l d l g t c b log q  
v l b 19 47
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I d m I t g b p l y o f t h t r u d t b  
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F i l A l J t t m l d h l  
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363
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l p t u b e s a f t e r t h j c t n o f o d e d l  
S g C y c & O b t 197 l 9
- 9 J S C H U M v i r s P M y m d c u n d a d e s a f  
r o t n l o g h W e Z e n t l b l f G y n e k  
96 l 3 69
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d k l k d r e n w e i b l h G e s c h i c h t t l  
e r m t t e l t J e n t g t l l d e s C a u m t r  
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c d 53
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R L I G S A a d A y n O I M t s a l  
p g p h a c l R t g t d n u e b e d e A t o m  
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3 S C R D J A I p o d n o t c o y l p t e r a p A c h  
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p p l P t t l e A t t l d h 96  
6

## BENIGN PROSTATIC HYPERTROPHY

A REVIEW OF ONE THOUSAND CASES<sup>1</sup>

BY AEPNE C HUNT M D F A C S R CHILSTER MIN TSOTA  
D B F S g y M J C I

**E**XPERIENCE in the treatment of benign prostatic obstruction during recent years has led to the development of certain principles which have contributed materially to the reduction of the mortality rate and to the safety of surgical treatment of the disease. Recognition of disease associated with prostatic obstruction directly or indirectly the result of the obstruction as well as recognition of disease coincident with prostatic obstruction incident to the age at which prostatic disease occurs has served to weld the interest of the internist urologist and surgeon in the treatment of this condition.

Often grave organic disturbances are associated with prostatic obstruction and although obstruction may be primarily significant the coincident organic disease must be reckoned with in the treatment of the patient. The stresses and strains of life result in degenerative changes in the cardiovascular system. The renal excretory mechanism is usually directly affected by prostatic obstruction and renal insufficiency results however renal function may be impaired directly by organic disease of the cardiovascular system in the absence of prostatic obstruction. Willius studied the records including electrocardiographic data of a large series of cases of prostatic hypertrophy and noted cardiovascular disease in 42 per cent. He concluded that the incidence of cardiovascular disease is higher with prostatic obstruction than with many other diseases during the same decades indicating that cardiovascular disease is aggravated by persistent urinary retention.

Unquestionably renal insufficiency is a factor in decreasing cardiovascular reserve in prostatic hypertrophy. The improvement of the cardiovascular reserve coincident with improvement of renal function following gradual decompression of the bladder and prolonged urethral or suprapubic drainage is

noteworthy in conjunction with Willius' observation on the incidence of cardiac disease in cases of prostatic hypertrophy. I have observed numerous patients in uræmic states and on the point of a cardiac break whose cardiovascular renal reserve has been so restored by drainage that operation could be performed safely and successfully.

It is imperative to the successful treatment of prostatic obstruction that the condition be looked on from a general medical point of view not alone by the urologist as a disease of the urinary tract not alone by the surgeon as a lesion requiring operation but by the internist as a systemic disease for there are aspects which may be best appreciated by the physician.

I have recently reviewed a series of 1000 consecutive cases of benign prostatic obstruction in which suprapubic prostatectomy was performed. The review serves as a basis for certain facts and observations presented here.

## INCIDENCE AND SURGICAL INDICATIONS

True adenomatous hypertrophy comprises about 85 per cent of benign obstructing prostatic lesions the remaining lesions being of the inflammatory or prostatitic type. While the inflammatory type is encountered often at an earlier age than adenomatous hypertrophy there is little difference in the age incidence in cases of obstruction and retention from the two types of glands. Prostatic fullness and enlargement is found on careful digital examination of more than 50 per cent of men aged 50 years however the incidence of obstruction and the symptoms of benign prostatic disease are rare at that age or under that age. The average age in this series is 64 years (Table I). The amount of enlargement of the gland can often be ascertained on careful digital examination. A small gland may produce intra urethral obstruction and complete retention. On the other hand a

TABLE I—AGE OF ONE THOUSAND PATIENTS

S m d d	P	t	P	t
40-45	3		3	
46-5	3		3	
5-55	8		8	
56-60	77		77	
6-65	33		33	
66-7	6		6	
7-75	3		3	
6-80	5		5	
8-85	6		6	
96-90				

011  
V 3 p f i  
f j m h f  
f j m h f g ty

huge intravesical gland may provide adequate urethral passage without urinary retention. The moderate sized gland is the usual enlargement productive of retention, frequency, difficulty, and so forth (Table II). The large gland (graded 4) becomes surgical at a slightly later age than the smaller gland (Table III), indicating that even though there is very marked intravesical enlargement, mechanical obstruction may not occur early.

Experience has established the indications for operation on the basis of prostatic enlargement and residual urine. Except under the conditions of moderate or marked enlargement of the gland without urinary retention or residual urine productive of frequency, pain, difficulty, and so forth, should prostatectomy be undertaken without reservations on the amount of benefit that may be expected? Cystoscopic examination is hardly to be recommended in all cases of prostatic obstruction; however, a small gland with no appreciable enlargement but with symptoms simulating those of prostatic disease without obstruction usually requires cystoscopic examination. Braasch and his associates have followed the principle of employing cystoscopic examination only in those cases in which observations on digital examination do not unreservedly explain the urinary symptoms. In other words, without entering into a consideration of the symptoms and diagnosis of prostatic disease, it is essential that all such cases should be given careful urological consideration. Too often normal prostate glands have been removed for symptoms produced

TABLE II—DEGREE OF ENLARGEMENT OF PROSTATE GLAND DETERMINED IN EIGHT HUNDRED AND SEVENTY CASES BY RECTAL PALPATION, CYSTOSCOPY OR OPERATION

El g m	C	P	t
( d 1	79	8	7
( l 1	39	4	5
(ra l 1 3	74	33	9
( d d 4	63	7	8

by lesions higher in the urinary tract and readily revealed by careful examination. Retention and residual urine when definitely attributed to the prostate form the true indications for prostatectomy. It is questionable whether prostatectomy should be considered in the absence of residual urine or retention unless the gland is extremely large and frequency resulting from decreased bladder capacity causes disability. Certainly prostatectomy for the removal of a small gland not producing obstruction but for the purpose of relieving the major symptom of frequency is not accompanied by results which would justify the operation. Obstruction must be present to some degree before one may expect justifiable results, and usually the results are good in proportion to the degree of obstruction present.

In this series of 1000 cases urinary retention requiring catheterization had existed in more than 50 per cent. The retention varied from one acute attack to chronic or continuous retention requiring constant catheterization. About 23 per cent of the patients on admission to the clinic or to the hospital had either complete retention or were retaining urine to the full capacity of the bladder in many instances there was involuntary leakage. This is a higher incidence than previously noted. In an earlier series of cases the incidence of complete retention was about 16 per cent. Obstruction unless to the degree of complete retention usually results in only a moderate amount of residual urine. In this series the amount varied from 30 to 300 cubic centimeters in approximately 66 per cent (Table IV). The size of the gland fails to serve as a criterion of the degree of obstruction (Table V) except that a higher percentage of large glands are productive of complete retention than the smaller gland.

TABLE III—AGE OF PATIENTS AND DEGREE OF ENLARGEMENT OF PROSTATE GLAND DETERMINED IN EIGHT HUNDRED CASES

Size in decades	G d 1	G d 2	G d 3	G d 4	G
40-45		2	1		3
46-50	3	10			3
51-55	12	44	15		73
56-60	0	9	55	5	171
61-65	16	105	92	19	322
66-70	16	101	75	1	273
71-75	7	25	26	16	74
76-80	1	8	5	5	19
81-85			2	1	3
Total	75	391	271	63	800

## PRE OPERATIVE TREATMENT

Experience has shown that the patient with prostatic obstruction is as a rule a poor subject for immediate operation. It would seem that the patient who has been about his work and who on examination appears to be in good physical condition with satisfactory cardiovascular system and little or no demonstrable renal injury resulting from moderate obstruction and urinary retention should not experience particular hazard in immediate operation. This however is not the case. Some time ago in a review of the relationship of preliminary treatment to mortality rate following prostatectomy I presented data showing that the mortality rate in the apparent relatively preferred surgical risk if operation was performed without pre-operative preparation approached very nearly that accompanying prostatectomy after adequate pre-operative treatment in the group of cases in which the general condition was poor and there was marked renal insufficiency, infection of the urinary tract and cardiovascular disease. The merits of preliminary treatment in all cases have been definitely established and it may be asserted that prostatectomy should never be performed without a period of preliminary treatment. Drainage of the bladder is of prime importance and unless there are good reasons for cystostomy drainage should

TABLE IV—AMOUNT OF RESIDUAL URINE IN SEVEN HUNDRED AND SIXTY CASES

C b	t m t	C	P	t
None		31	4	0
30		79	10	3
60		81	10	6
90		6	8	1
91-100		108	14	
151-300		147	19	3
301-450		4	5	5
451-600		1		7
601-700		3		
701-800		3		
801-1000		7		
All urine retained	dual	1	23	1
Total		60		

be established by a permanent indwelling urethral catheter and continued until the cardiovascular renal reserve has been restored to the point of relative safety for operation.

During the last 3 years in the clinic the principle of preliminary treatment in all cases for a minimum of 10 days has been carried out. A period of from 10 to 12 days of urethral catheter drainage in those patients in relatively good condition comprising a group that was formerly operated on without preparation has resulted in marked reduction of mortality rate. Permanent urethral catheter drainage of the bladder is the method of choice for it facilitates the one stage visualized operation. Suprapubic drainage is necessary under the conditions of associated vesical lesions such as stones and diverticula and in those cases of marked renal insufficiency requiring a long period of drainage preliminary to prostatectomy. Intolerance to the urethral catheter likewise occasionally requires suprapubic drainage but in my experience this occurs in only about 6 per cent of the patients. Suprapubic drainage as such provides an excellent method of preparation and insures the greatest safety in the management of patients in poor general condition however that it justifies adoption in all cases is questionable. The disadvantages of inaccurate subsequent prostatectomy places it in disfavor as a method of choice in comparison to urethral catheter drainage with the subsequent one stage visualized operation. During the period of drainage stabilization of renal function occurs with marked improvement in the general condition of the patient who has experienced

TABLE V—AMOUNT OF RESIDUAL URINE AND DEGREE OF ENLARGEMENT OF THE PROSTATE GLAND IN SEVEN HUNDRED AND THIRTY-THREE CASES

C b	m t	G d	G d	G d	G d	C
		3		5		3
10-5		34	8	9	6	33
5-3		4	67	48	5	34
3-000		4	3			5
1-900				3		6
1				3		7
All	d l	3	56	6	3	18
Total		68	357	4	6	733

much depletion of organic reserve. In this series suprapubic drainage was the method of choice or necessity in the pre-operative management in 28.8 per cent of the patients. Inasmuch as suprapubic drainage was reserved for those patients in poor general condition and those with complication it is natural that the time between drainage and subsequent prostatectomy should be longer than if the two-stage operation were used generally. It has not seemed wise to consider prostatectomy in any case in less than 3 weeks from the cystostomy. Approximately half of the patient were operated on within an interval of 3 months; however the time interval in 1 per cent of the patients was by necessity more than 100 days and in three patients more than a year intervened between suprapubic drainage and prostatectomy.

While the general condition of the patient is the important guide to the time at which prostatectomy may be considered the renal functional tests serve to indicate the danger of operation rather than its safety. These tests do not serve as a means of determining renal reserve; however a constantly low phenolsulphonephthalein return or a persistently high blood urea estimation indicates a narrow margin of renal reserve and only under most unusual circumstances may prostatectomy be undertaken with any degree of safety if the phenolsulphonephthalein return is less than 20 per cent or if the stabilization of the blood urea is much more than 50 milligrams for each

TABLE VI—CAUSE OF DEATH IN FIFTY-FOUR CASES

C	l	p	C
Uremia			1
Pyelonephritis			9
Pylonephritis			8
Myocarditis			5
Cerebral			3
Pulmonary			3
Bleeding			1
Pneumonia			1

100 cubic centimeters. Uremia and pyelonephritis still occupy the position of the most important causes of death following the operation and usually produce death when irreparable renal injury has occurred secondary to long standing retention and infection of the urinary tract.

#### SURGICAL CONSIDERATIONS

Two-stage suprapubic prostatectomy is the procedure of choice and necessity under certain circumstances and provides a method of surgical procedure which under such circumstances and in the presence of complications carries the minimal risk. However the one-stage visualized operation is gradually becoming more and more the one of choice and when employed in properly selected cases after adequate pre-operative preparation is accompanied by a minimal mortality rate and excellent functional results. In this series the one-stage operation was performed in 72 per cent of the cases.

Certain phases of the surgical procedure are worthy of repetition and emphasis. Recent changes in the types of anesthetic used for operations in this field have exerted a marked influence on postoperative complication and mortality. Either as a general anesthetic prevents the greatest hazards in cases of prostatic obstruction, not in its administration for there is a wider margin of safety during ether anesthesia than in that produced by other general anesthetics but in the subsequent renal depression and acute pulmonary complications. The various gas anesthetics have much to commend them; however unless skillfully administered they often produce cyanosis when anesthesia is carried to the point of complete relaxation. Lundy has recently called attention to the deleterious effect

TABLE VII—RESULTS OF OPERATION IN SIX HUNDRED AND FIFTY SIX CASES (TWO YEARS OR MORE AFTER OPERATION)

Cases	Per cent
Practically well	337 54.4
Marked improvement	180 28.8
Slight improvement	86 13.4
No change	24 3.6
Total	636

of repeated cyanosis. Regional anesthesia which has properly displaced general anesthesia in this field of surgery minimizes postoperative renal depression and pulmonary complications from inhalation.

The visualized one stage operation provides exposure for accuracy in conduct of operation and application of hemostatic measure. Accurate hemostasis is most important. Continued postoperative bleeding rapidly reduces resistance to infection and while few patients under modern surgical methods succumb directly from excessive loss of blood continued bleeding exerts a profound influence on mortality through the subsequent advent of general sepsis or pyelonephritis. The Pilcher bag used in 850 cases has proved a most effective method of hemostasis when utilized with hemostatic control by suture at the vesical neck.

So far as mortality is concerned it is possible to obtain an incredibly low rate for a considerable time and for a considerable number of consecutive cases either through particular good fortune or careful selection of patients denying the benefits of operation to those patients with a narrow margin of cardiovascular renal reserve. Accepting as contra indications to prostatectomy only such conditions as cardiac decompensation, coronary sclerosis with evidence of marked myocardial injury and advanced malignant hypertension, operation was performed in 140 consecutive cases after adequate preoperative treatment with but one death. Four deaths occurred however in the next 54 cases so that the mortality rate in the 194 cases in which operation was performed during that year was 2.5 per cent. On the other hand previous to the adoption 3 years ago of the principle of preoperative drainage in all cases 36 per cent of the patients were operated on without preoperative preparation with a mortality rate of 6.6 per cent. A

TABLE VIII—SEXUAL POWER IN SEVEN HUNDRED AND TWO CASES

	Cases	Per cent
Normal before and after operation	29	32.6
Normal before and after operation	180	26.6
Normal before and after operation	196	7.9
Impaired before and after operation	97	13.8

four per cent of mortality rate may be obtained only on the basis of an average over a period of years. The mortality rate in the 1000 cases in this series (for a period of about 8 years) was 3.4 per cent and includes all death even though in some instances death was due to conditions apparently not related to the operation. General sepsis, uremia and pyelonephritis were the most important causes of death. Pulmonary embolism was the cause of death in 8 cases, coronary sclerosis in pneumonia, and bleeding duodenal ulcer in 1 (Table VI).

## RESULTS OF OPERATION

As one must depend largely on the patient's statement regarding the symptoms of prostatic obstruction and the amount of disability produced, one must likewise depend on his statement regarding the benefit derived from treatment. The results of prostatectomy are very gratifying: about 85 per cent of patients are completely or almost completely relieved of all symptoms of prostatic disease (Tables VI and VII). A small group of patients experience no change in urinary frequency which in many instances on re-examination has been found due to pre-existing progressive pyelonephritis and infection of the urinary tract. Certainly the incidence of residual urine and the formation of vesical calculus and so forth is small after complete removal of the obstructing gland.

## SUMMARY

The point is emphasized that the case of benign prostatic obstruction is largely medical; a surgical condition is present but there are aspects which may best be appreciated by the physician. Only through the combined interest and co-operation of the internist, urologist and surgeon can the patient be operated on with the minimal risk and assurance of the best functional result.

## NEUROBLASTOMA OF THE ADRENAL IN YOUNG CHILDREN

BY MAI THA WOLFFLIN M.D. NEW YORK

PRIMARY tumors of the adrenal medulla occurring in young children congenital in origin and malignant in course have been known for a long time. They appear in the literature under various names. Thus Virchow (1) in 1864 decided to classify tumor of the adrenal medulla as gangliomata. Marchand (11) in 1891 described a tumor originating from the sympathetic part of the adrenal having cells and fibrils which on cross section gave a granular appearance. He also noted the resemblance to round cell sarcoma. Kretz (6) in 1900 suggested that the round cell sarcoma of the adrenal and liver reported in young children originated from the formative cells of the sympathetic system. Tepper (14) in 1901 and Hutchison (5) in 1907 published series of similar tumors under the name of suprarenal sarcoma. It was Wright (20) in 1910 who studied this group of neoplasms collected 8 from the literature and described 4 of his own under the name of neurocytoma or neuroblastoma of the adrenal medulla. Wright drew attention to the similarity of the morphology and arrangement of the cells and fibrils in the neoplasms to that in theanlage of the adrenal and the sympathetic nervous system at certain periods of their development. Lindau (8) in 1913 used the name malignant sympathetic blastoma. Wolbach (19) preferred the name neuroblastoma sympathicum to indicate that the embryonal nerve cells composing the tumor belong to the sympathetic nervous system. On the basis of the most recent histological investigation Bulcy and Cushing (3) prefer the name sympathicoblastoma because as they point out not all the cells in the tumor are potentially neuroblasts since some of them may differentiate into chromaffine cells. The sympathicoblastoma is a malignant neoplasm originating from embryonal pluripotential cells of the sympathetic nervous system. While the majority of the reported tumors of this type have been found in or growing from

the adrenal medulla they may grow from embryonal sympathetic cell or sympathicoblasts anywhere in the body. Thus tumors not involving the adrenal gland have been reported by Landau (8) from the abdominal sympathetic chain in a girl of 8 months and by Boyd (4) in a boy of 4 1/2 years. Martius (12) described one from the cervical sympathetic chain in a boy 1 1/2 years old. The interesting case reported by Anitschkow (1) originated in front of the lumbar spine and invaded the crura equina. Anderson and Shennin (1) found a neuroblastoma growing in the apical region of the right lung in a girl 1 week old. The case reported by Pick (15) originated from the uterus and Ritter's (16) adult case grew from the intestine.

At the Babies Hospital we have accumulated a series of 9 adrenal sympathicoblastomas proved by microscopic study of the tumor at operation or at autopsy. Three were diagnosed clinically but not confirmed by microscopic study are not included in this series. The 6 neoplasms fall into several distinct groups clinically and anatomically.

The simplest tumor of the series has several points in common with Marchand's (11) case briefly recorded in 1880 and minutely described in 1891.

CASE 1. D. K. 1 male infant prenatally no left sympathetic chain puller and left breast 1 1/2 years old at birth and was breast fed for 7 weeks. Since then she has never done well. At birth had a large lump in the left kidney region. The lump was felt in the left kidney region. The lump was palpable and x-ray examination of the abdomen gave a negative result. The child was very feeble and ill when 6 weeks old. At autopsy the acute cause of death as found to be bronchopneumonia. The left adrenal contained a globular tumor measuring 4 by 4 centimeters in diameter. It was smooth yellow and situated in the suprarenal capsule covered by thin layer of compressed peritoneal coat. The tumor was 1 centimeter thick. The tumor occupied the lower half of the gland leaving the upper half of normal dimensions. On section the growth had an irregularly rough trabeculated appearance. The left kidney was red

5/ by 2 centimeters. Its upper half was indented to receive the globular adrenal tumor. The right kidney measured 5 by 3 centimeters and was capped by a normal adrenal measuring 2 by 1 centimeter (Fig. 1). Microscopic examination showed the tumor to be divided into irregular alveoli by thin fibrous connective tissue septa carrying blood vessels. The alveoli were filled with masses of small round cells with deeply staining nuclei and little cytoplasm. Some mitoses were present. Between the round cells lay bundles of delicate fibril which took the eosin stain but not the special collagen fibroglia or neuroglia stains of Mallory (10) (Fig. 2). There were a number of pseudorosettes first described by Kuester (7) where the cells were arranged around a central mass of fibrils (Fig. 3). The adrenal medulla beyond the tumor was unusually rich in round cells with hyperchromatic nuclei. The cortex of the compressed adrenal tissue surrounding the tumor was normal in arrangement but very narrow (Fig. 4). The kidney showed no involvement in the neoplastic process. No metastases were present in any organ.

Slightly more complicated were the cases of two young infants admitted to the hospital with enlarged livers in which nodules were palpable. The younger was only 3 weeks old and the mother had noticed the large abdomen during the third week of life.

**CASE 2.** The infant was born at term after a normal labor. The diagnosis on admission lay between birth sepsis with peritonitis and neoplasm of the liver. The child died on the second day in the hospital. At autopsy the liver weighed 690 grams. It was filled with metastatic tumor nodules yellowish in color with a central zone of hemorrhage (Fig. 4). The primary growth was in the right adrenal forming a globular mass 4 by 3 centimeters in diameter, cupping the right kidney. On the upper border of the tumor a small compressed piece of adrenal remained. This is a characteristic feature of the sympathicoblastomata. The growth was red, soft and haemorrhagic. The left kidney and adrenal were both normal. Microscopic examination showed that the primary tumor was composed of round cells aggregated into masses with bundles of eosin staining, delicate fibrils ramifying between and around the cell groups. The small cell had hyperchromatic nuclei. There was a small number of larger cells with nuclei vesicular in character. A section made through the part of the adrenal gland attached to the upper border of the tumor showed the cortical layers maintained in normal conformation but at one point the tumor cells had invaded the reticular zone. The entire medulla was transformed into the tumor. Pseudorosettes were present. Sections of the liver metastases showed a more distinctly alveolar arrangement with cells similar to those in the primary tumor but fewer fibrils and larger vessels. Landau (8) has pointed out that the more

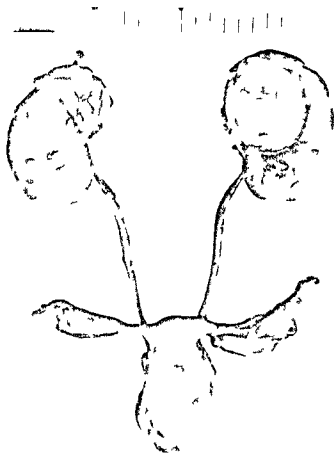


Fig. 1. Male infant, 6 weeks old. Shown sympathicoblastoma of the left adrenal capping the kidney and an undistorted portion of the adrenal. There were no metastases.

rapidly growing portion of these growths are less rich in fibrils. No other organs showed metastases and the abdominal lymph nodes were not enlarged.

**CASE 3.** A male infant 4 months old was brought to the dispensary for rhinitis. The liver was found to extend 2 finger breadths below the costal margin. Five months later he was admitted to the hospital with an acute bronchopneumonia. The mother said that she had noticed distention of the abdomen the day before. At the time of admission the lower border of the liver reached the iliac crest. The child died 9 hours later and at autopsy the liver weighed 827 grams. The whole organ was studded with round nodules varying in size from 2 millimeters to 3 centimeters in diameter. Some of the smaller nodules were gray but the larger ones were soft with a central zone of hemorrhage. Little normal liver substance was left. The right kidney weighed 32 grams and was normal in size. The right adrenal weighed 1.5 grams and surmounted the kidney as usual. The left kidney was 7 centimeters long and was capped by a globular mass 6 by 5 centimeters in diameter showing on its upper pole a small flattened portion of adrenal only 1 to 3 millimeters thick. The tumor and kidney weighed 84 grams (Fig. 5). Microscopic examination gave the characteristic picture of sympathicoblastoma with pseudorosette formation.



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B. MARTHA WOLSTEN, M.D., N. Y. Rk.

PRIMARY tumors of the adrenal medulla occurring in young children congenital in origin and malignant in course have been known for a long time. They appear in the literature under various names. Thus Virchow (1) in 1864 decided to classify tumor of the adrenal medulla as gangliomata. Marchand (11) in 1891 described a tumor originating from the sympathetic part of the adrenal having cell and fibrils which on cross section gave a granular appearance. He also noted the resemblance to round cell sarcoma. Kretz (6) in 1902 suggested that the round cell sarcoma of the adrenal and liver reported in young children originated from the formative cells of the sympathetic system. Pepper (14) in 1901 and Hutchins (5) in 1907 published series of similar tumors under the name of suprarenal sarcoma. It was Wright (2) in 1910 who studied this group of neoplasms collected from the literature and described 4 of his own under the name of neurocytoma or neuroblastoma of the adrenal medulla. Wright drew attention to the similarity of the morphology and arrangement of the cells and fibrils in the neoplasms to that in the anlage of the adrenal and the sympathetic nervous system at certain periods of their development. Landau (8) in 1911 used the name malignant sympathetic blastoma. Wolbach (19) preferred the name neuroblastoma sympathicum to indicate that the embryonal nerve cells composing the tumor belong to the sympathetic nervous system. On the basis of the most recent histological investigation Bailey and Cushing (3) prefer the name sympathicoblastoma because as they point out not all the cells in the tumor are potentially neuroblast. Since some of them may differentiate into chromaffine cells. The sympathicoblastoma is a malignant neoplasm originating from embryonal pluripotential cells of the sympathetic nervous system. While the majority of the reported tumors of this type have been found in or growing from

the adrenal medulla they may grow from embryonal sympathetic cells or sympathicoblasts anywhere in the body. Thus tumors not involving the adrenal gland have been reported by Landau (8) from the abdominal sympathetic chain in a girl of 8 months and by Boyd (4) in a boy of 4½ years. Martius (1) described one from the cervical sympathetic chain in a boy 2½ years old. The interesting case reported by Anitschkow ( ) originated in front of the lumbar spine and involved the crura equina. Anderson and Sherman (1) found a neuroblastoma growing in the apical region of the right lung in a girl 1½ weeks old. The case reported by Pick (15) originated from the uterus and Ritters (16) adult cases grew from the intestine.

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The simplest tumor of the series has several points in common with Marchand's (11) case briefly recorded in 1880 and minutely described in 1891.

CASE 1. D. K., a female infant presented no distinct symptoms except pallor and failure to gain. She was normal at birth and was breast fed for 7 weeks. Since then she has never been well. Acute rachitic development. She was admitted to the hospital when 18 months of age as large as the end of a man's thumb. She was felt in the left kidney region. Nephrectomy was performed and a rare carcinoma of the abdomen gave a negative result. The child was very feeble and died when 16½ weeks old. At autopsy the acute cause of death was found to be bronchopneumonia. The left adrenal contained a globular tumor measuring 4 by 4 centimeters in diameter. It was smooth yellow and situated in the upper adrenal medulla covered by a thin layer of compressed supracortical cortex about 1 millimeter thick. The tumor occupied the lower half of the gland leaving the upper half of normal dimensions. On section the growth had an irregularly rounded abscutaneous appearance. The left kidney measured



FIG. 5. Male infant 9 months old. Adrenal sympathicoblastoma cupping the kidney. The kidney and tumor weighed 84 g. ans.

a boy 3 years old who died during the operative attempt to remove the orange sized tumor in the left adrenal which had metastasized into the bones of the skull the ribs and the mesenteric retroperitoneal mediastinal cervical and inguinal lymph nodes.

CASE 5. A similar but less generalized case was that of a boy of 18 months who was admitted with a history of having been pale for 6 months with irritability and occasional fever. He had a soft irregular nodule behind the left ear 5 by 4 centimeters in diameter. In the left upper quadrant and across the lower portion of the abdomen there was a palpable hard mass which was not tender. Coil of intestine were felt in front of it. The liver extended 2 centimeters below the costal margin and the spleen 3 centimeters. There was a nodule over the middle portion of the left clavicle 4 by 2 centimeters in diameter. The right knee was held rigidly in a slightly flexed position. It was swollen and tender and measured 1 centimeter more than did the left knee. Palpable lymph nodes were found in the suboccipital posterior cervical axillary and right inguinal groups. The child died 3 days after admission. At autopsy the primary tumor 9 centimeters long with a circumference of 5 centimeters was found in the left adrenal (Fig. 8). Just behind the pancreas a mass 3 centimeters in diameter surrounded the aorta. Metastatic nodules were found in the liver the retroperitoneal lymph nodes the

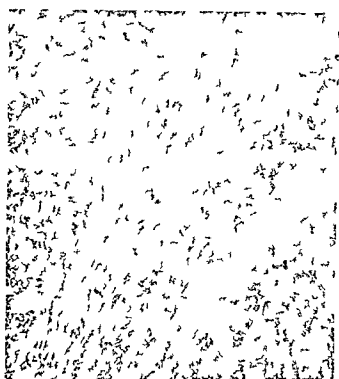


FIG. 6. The microphotograph showing the infiltration of sympathetic tissue into the lumbar and thoracic small group of the

twelfth left rib and the left kidney pelvis. Microscopic examination showed that the primary tumor and the mass in front of the aorta were both sympathicoblastomata which had metastasized into the liver bones and lymph nodes. The mass in front of the aorta was interesting and was found in two other cases in our series. It evidently originated from the sympathetic ganglia normally developing in that position.

A tumor originating in this region and not involving the adrenal has been reported by Landau (8) in a girl 8 months of age. In our case the prevertebral tumor and the adrenal tumor each represented a primary focus. In Wahl's case (18) a peri aortic mass originated from the coeliac plexus.

There were two cases in the series in which an inoperable retroperitoneal mass was found on exploratory incision and the origin of the neoplasm could not be determined at operation. Both the children were about 1 year of age.

CASE 6. The older was a girl of 26 months who had been born at term and had been bottle fed. The mother said that she had always had a big high stomach and brought her to the hospital because 3 weeks before she had felt a lump in the baby's left side. This mass was found to be inoperable and the child died on the sixth day after abdominal exploration. At autopsy a retroperitoneal tumor





FIG. 5. Male infant 9 months old. Abdominal sympathicoblastoma cupping the kidney. The kidney and tumor weighed 84 grams.

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ly m l h l y l d Sh k t h t  
hem h mp th t t m l k l m t l  
m t t t th l d t d m t

wa f un l in th kid ev r gon Th la g st p tion  
wa n th l ft d m as u ing 16 c nt i met rs n  
l ngth Th hol p im n con st l f th left  
k l n v capp d by large globular tumor by  
6 c nt i met rs in diamet r while th k l n v  
m u l nt meter n l ngth the right kid ev  
fr el m val l 7 b v 4 c nt i met rs and b t e n  
the v a n l u lar tumor o b v o c nt i met s (Fig  
9) Th nodular c ntral mass sho d on s t on the  
sam g an lar i gula l v al colar yello ish h t  
appe ane studd d th small h morrh g s cha  
cter sti f a l e c t ly mil r to th dr n l  
t mor It a notable because un sual that o  
p t of the left ad enal rema ed att a h e l t th  
gro th Th masse compo g the c t al tumo  
wer thr n number n l all v re globular The  
ven ava p s d thr ough the mass and wa l ghtly  
comp e s d by it S e al lymph n d s aying n  
s i f m to c nt meter i d ameter r incor  
por ted in t Th ght ad enal and k dney v re  
unaff c t d Th l ft kid n v cont ned a n opl stic  
nodule b v centim t in ne pyram d

In this in tance it is difficult to say whether  
the prevertebral masses evidently originating

from abdominal sympathetic ganglia or the  
growth in the left adrenal was the primary  
focus and the neoplasm probably originated  
from two foci Wahl interpreted his case as  
composed of three primary tumors

CASE 7. The other cr as a boy 23 months old  
h a th l v nth hld He ha l b n breast f d  
fr 4 m nth l ha l r cov r el from an attack of  
p r t u l l r 3 cks b f r adm sion he ha l com  
plan l of b l m n d p n and the mother b l e v l  
th t th al l m n v a growi g larger At the time  
f l m on th l v r x t e n l o centimeters below  
th t l margin Th ab l m n as dull in both  
fl k an l u d r n e the s a large mass was f l t  
an l t ight to l tta h e l t the liver Jaunice  
l v l p l an l th stool b came l y colo ed At  
p a t i n v r r t p e r t o n al mas as found to be  
pr ng n th un l r s fac f the l e r an l causing  
l t n t n f th gall bl d l e r hich as drai ed  
Th tum c u l l n t b r m v e d an l the child d d  
7 l v l u r Autop v e v al l a large retro p e  
t n al tum r in l y i n g b th ad r n al and extending  
m p l t l o the b l o m n l e a v i t y comp e g  
th l r The ght k l n v as embed l d in the  
m b t th l f t n v a s f Th t m o as al  
m t gl o u l an l a c m p s l of s v e r al no l u l e s  
h i h c e r m n l v l l a h white o ection  
int p r l th l g e c l a r a h morrhag The  
ght k l v u p p l an l narro e l th tumor  
mp i g b th i t u p p r p l e and it inner bor l r  
Withu t ab t c h e v r th r a no metas  
t a s Th left k l n v as n mal in size an l struc  
tur No ormal v r n al t su r m u n e d The p  
er v r p r l l y the tumor and na ro v e d  
to half t n r m l d r m t but its s b stance con  
t a i n o n l u l s The r t r p e to eal l s v e e  
all c n l a g l an l o m e of the mesenterics as e l l  
Th sple n w r n i t s m al p o s i t i o n a d sho ed no  
l o n M e r o o p e x a m i n a t i o n show d th char  
acter i s t r c t u r of sympatheticoblastoma with  
p u l s r s t e m a t n (Fig 10)

There were two cases which were more  
complicated in structure than 6 of the 7  
others and which histologically were both  
sympathicoblastoma and granuloneuroma  
The older of these two children was the oldest  
of our series being nearly 3 years of age

CASE 8. A boy born at te m r n l breast f d for  
years Wh n he was 8 months old the mothe  
not e l that the right s i l e of the ab l o m e n as har l  
He alk d at 15 m th s an l s e m l q i t e e l l b t  
h was b o u g h t to the ho p i t a l at th ag of nearl  
3 years b c a u s of the l u m p i the s i d and l i m p  
l h m a e x t n d e d from the l to th i l c e t  
Lapa tomy r p e r f o r m i d the right k d v  
with an a l a c n tumor a c e d The t u r  
mas weigh d 680 grams d c o s t d of n e l l i p  
t i c a l h a r d s m o o t h g r o t h l y g u p o n and in f o n t



FIG. 8. Male child 18 months old. Cross section showing the variegated appearance of the adrenal lymphaticoblastoma and part of the prevertebral mass.

of the right kidney which was entirely separate from the tumor and normal in shape and structure. The tumor was 18 centimeters long and 11 centimeters wide and its circumferences were 31 and 27 centimeters respectively. On section the lower part of the tumor was found to be red mottled soft areolar in appearance showing many yellow points of calcification some so hard that they grated against the knife. The upper third was white areolar and firm and contrasted with the softer embryonal appearance of the lower two thirds. The microscopic diagnosis was ganglioneuroma of the adrenal. The child recovered from the operation and could not be traced for final report.

CASE 9. The other patient was a boy 15 months old whose parents had been treated for syphilis 5 years before his birth. There had been 11 pregnancies and only 3 children were alive. The patient was born at term and was nursed for 9 months. He was brought to the dispensary because he was irritable, sleepless and underweight. His Wassermann reaction was negative. A hard globular mass was felt in the abdomen in the left upper quadrant. The liver was palpable. Axillary, inguinal and posterior cervical lymph nodes were palpable. The spleen was felt above the mass and reached only to the costal border. The urine was negative, the blood showed a moderate anemia. Operation was performed by Dr. Bolling and a large mass was removed with the diagnosis of adrenal neoplasm. Dr. Bolling's notes read as follows: An irregular nodular mass lying above but not adherent to the left kidney, retroperitoneal. There were no enlarged glands nor was there any evidence of extracapsular growth beyond the midline. The peritoneum lateral to the descending colon was incised and the tumor delivered with considerable difficulty, partly by blunt dissection and partly by isolating adhering areas containing bleeding vessels and cutting between ligatures. There was no connection with the kidney. After removal of the tumor no attempt was made to suture the incision in the peritoneum. The wound

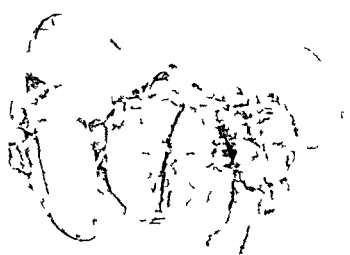


FIG. 9. Female child 1 year old. Shown an inoperable lobulated mass and large globular sympatheticoblastoma in the left renal area.

was closed in layers with three retention sutures. The child's condition was fair throughout.

The specimen was an elliptical mass weighing 140 grams. It measured 9 by 7 by 3 centimeters. The surface was irregularly nodular and the capsule roughened but intact. Adherent to the posterior surface was a much compressed piece of adrenal gland 5 centimeters long, 2 centimeters wide and 2 millimeters thick (Fig. 11). It was possible to dissect this portion of adrenal free so that both surfaces were seen to be flattened and on section the cortex and medulla were only a line in thickness. Its upper end merged into the tumor and could not be separated from it. The cut surface showed that the neoplasm was composed of small round lobules varying in size from 3 millimeters to 1 centimeter in width. These were either pink or dark red in color with yellow areas of inspissated blood. At the upper pole of the tumor there was a pink, even smooth, dense area, 1 centimeter wide and 3 centimeters long which had the smooth appearance of a sarcoma quite in contrast to the variegated appearance of the rest of the growth.

Microscopic examination of a section from the upper pole of the tumor including the dense (pink) area showed that the structure of the soft central portion differed from that of the periphery. In the former were masses of cells varying in size and shape, arranged in smaller and larger alveoli bounded by cellular fibrous tissue. The cells were partly round and small, partly larger and multinucleated, and partly triangular in shape, some of them had nuclei at either pole and none showed mitotic figures. Between the cells were masses of delicate fibrils, some of which were connected with the cells. Definite pseudopodocytes were seen. The blood vessels were small and numerous, carried by the connective tissue between the alveoli. In the dense pink layer at the periphery of the tumor large cells like adult ganglion cells were numerous (Fig. 12) while masses of nerve fibers having a definite neurolemma formed

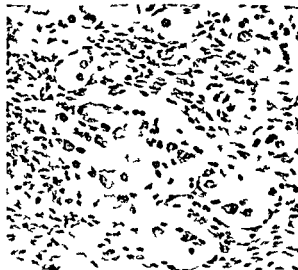


Fig. 1. Hematoxylin and eosin stain. (H. E.)

Fig. 2. Hematoxylin and eosin stain. (H. E.)

The following cases are from the files of the Children's Hospital, Boston, Massachusetts. The first case is that of a boy, 11 months old, who was operated upon by Dr. Bolling, the only one recorded who was alive one year after operation.

Lehmann (9) reported the case of a boy who was well 1 month after operation performed when he was 11 months old. The child operated upon by Dr. Bolling, the only one recorded who was alive one year after operation.

In our group of 9 cases of neuroblastoma of the adrenal medulla there were 3 boys and 6 girls. The tumor involved the left adrenal in 4 cases, the right in 4, and both adrenals once. The age of the children varied from 3 weeks to almost 3 years, 3 being under the age of 1 year, 3 in the second year, 3 in the third year. There are 5 different types in this series according to the location of the primary tumor and of its metastases. Thus we have first the simplest case of the series in which a small nodule was found in the left adrenal leaving the greater portion of the organ in an apparently normal condition and forming no metastasis. This tumor showed microscopically the most typical and exquisite

structure of embryonal sympathetic cell and fibril according to Wright's classical picture.

The next type is illustrated by case both in young infants, 3 weeks and 9 months old respectively, and both boys. The younger child showed the tumor on the right side, the older one on the left side. Both developed metastases in the liver, enlargement becoming so great that it was the outstanding symptom. No other metastases were present. While cases of this type occur most often in young infants, Wolbach and Morse (19) have reported a case in a boy 4 years old.

The third type conforms to what has been known as the Hutchison type (5) of round cell sarcoma of the adrenal. It is represented in our series by cases 1 boy and 1 girl 18 months and 31 months old respectively. In the latter it was the right adrenal which was affected, while in the former the left side was the seat of the primary growth. Both showed metastases over a much wider area involving bone of the skull, the ribs, the pelvis, the clavicle and the liver, and in the case of the girl the dura mater. The liver was involved to a much less extent than was the case in the second group. The children thus affected are more often in the second or third year of life. In spite of the differentiation of part of the growth into a ganglioneuroma, metastases of sympathicoblastoma were present when the child was first seen.

In the fourth group there are again patients a boy of 23 months and a girl of 6 months. In the boy both adrenals were affected in the girl only the left. Both of the cases were characterized by an inoperable tumor lying in front of the vertebral column between the adrenals and kidney making a mass from which kidneys, adrenals and node had to be painstakingly separated and dissected. In both children the prevertebral mass represented a second tumor focus. Landau's (8) case of an 8 months old girl had a neuroblastoma primary in the retroperitoneal lumbar region which metastasized into the liver. In our case there was a metastasis in the kidney on the same side as the large tumor in the adrenal. The right sided tumor compressed the liver but did not invade it and jaundice developed because of the mechanical effect of the tumor on the common duct.

The final group was the most interesting of all and comprised tumors from the right adrenal of a 3 year old boy and the other from the left adrenal of a boy 13 months old. Both were removed by operation and the younger child is alive 1 year and 5 months later. It is characteristic of both of these tumors that they were entirely separate from the kidney which was not compressed or deformed by the growth. In all the 7 other cases the upper pole of the kidney was cupped to receive the globular adrenal neoplasm. In the last 2 cases the neoplasm was also globular but it was entirely separate from the kidney and readily removable without it. In both cases a small much compressed portion of the adrenal remained on the upper pole of the neoplasm and this portion of the adrenal gave a normal histological appearance. It is characteristic of all the adrenal tumors that their cut section has a granular irregular alveolar appearance described by Wahl (18) as variegated and unlike the soft brain like consistency of the embryonal kidney sarcoma.

The tumors of the fifth group showed two distinct portions on section. One was pale pink, very firm and even in appearance while the other had the granular roughened appearance characteristic of all adrenal neuro-

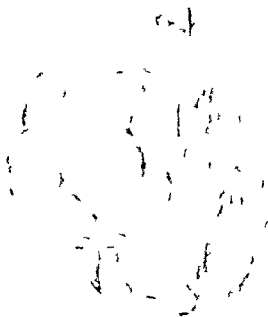


Fig. 1. Male child 13 months old. The adrenal neoplasm removed by Dr. B. H. N. The child is alive 1 year later.

blastomata. Microscopic examination showed that the firmer portion was characterized by the presence of many large adult nerve cells with distinct nuclei and nucleoli while the other portion of the tumor was composed almost entirely of the embryonal type of sympathetic nerve cells with numerous fibrils representing axis cylinders. Chromaffin cells were not present and both tumors were classified as neuroblastoma and ganglioneuroma. Martius' tumor of the cervical sympathetic while chiefly a neuroblastoma presented one firm nodule which was a ganglioneuroma. Wahl's tumor in a girl 1 year old contained areas of neuroblastoma, ganglioneuroma and chromaffin tumor all being variously differentiated stages of the same embryonal pluripotential cell.

Clinically the most rapidly fatal cases are those which present the large liver as the main symptom. The tumors which metastasize to the bones often present swelling and discoloration of the lid of one or both eyes as the first symptom. The adrenal primary tumor being found on abdominal palpation. The sympathicoblastomata originating in the adrenals and in the abdominal sympathetic ganglia resulting in a prevertebral mass





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The tumors of the fifth group showed two distinct portions on section. One was pale pink very firm and even in appearance while the other had the granular roughened appearance characteristic of all adrenal neuro-



Fig. 1. Male child 1 month old. The adrenal sympatheticoma and ganglioneuroma removed by Dr. Bolling. The child is alive 1 year later.

blastoma. Microscopic examination showed that the firmer portion was characterized by the presence of many large adult nerve cells with distinct nuclei and nucleoli while the other portion of the tumor was composed almost entirely of the embryonal type of sympathetic nerve cells with numerous fibrils representing axis cylinders. Chromaffin cells were not present and both tumors were classified as neuroblastoma and ganglioneuroma. Martius tumor of the cervical sympathetic while chiefly a neuroblastoma presented one firm nodule which was a ganglioneuroma. Wahl's tumor in a girl 2 1/2 years old contained areas of neuroblastoma, ganglioneuroma and chromaffin tumor all being variously differentiated stages of the same embryonal pluripotent cell.

Clinically the most rapidly fatal cases are those which present the large liver as the main symptom. The tumors which metastasize to the bones often present swelling and discoloration of the lids of one or both eyes as the first symptom, the adrenal primary tumor being found on abdominal palpation. The sympathicoblastomata originating in the adrenals and in the abdominal sympathetic ganglia resulting in a prevertebral mass

between the adrenals and kidneys without metastases cannot be diagnosed with any degree of certainty. The rare sympathicoblastoma of the adrenal which are not adherent to the kidney and show areas of differentiated ganglion cell may be operable because they apparently do not metastasize early. They contain areas of neuroganglionoma as well as of sympathicoblastoma and it is the latter only apparently which forms metastase.

#### CONCLUSIONS

In a series of 9 sympathicoblastoma of the adrenal medulla in young children contained areas of ganglioneuroma in part of the tumor. One such tumor metastasized very generally to the bones, dura and liver. The other were removed by operation before metastase occurred. Both children recovered from the operation and one survived a year and 5 months afterwards the only one recorded to survive a long time.

In 7 of the 9 the tumor proved inoperable when first diagnosed.

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## THE INSULIN-GLUCOSE TREATMENT OF TRAUMATIC SHOCK

## A DISCUSSION WITH AN EXPERIMENTAL REPORT

BY IRL C. PADGETT, M.D. AND THOMAS C. ORR, M.D., I.A.C.S. KANSAS CITY, KANSAS  
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MUCH evidence has accumulated especially during the World War that indicates that the chief factor in the production of traumatic shock is a toxin developed in damaged tissue (1, 2, 4, and 11). The toxic agent is unknown but histamine is an example of a protein cleavage product which produces experimentally the classic picture of shock (9). It is probable however that histamine does not represent the only example of a protein autolytic toxin which will produce shock like symptoms. The toxins liberated as a result of bacterial activity have been suggested as being of a somewhat similar nature. Anaphylactic shock is probably an additional example of a similar protein cleavage product producing certain symptoms sometimes similar to those of shock (10).

## DEFINITION OF TRAUMATIC SHOCK

Cannon (4) in his monograph on Traumatic Shock defines the condition as follows: 'It is characterized by a low venous pressure, a low or falling arterial pressure, a rapid thready pulse, a diminished blood volume, a normal or increased erythrocyte count and hemoglobin percentage in peripheral blood (thereby differing from simple hemorrhage), a leucocytosis and an increased blood nitrogen, a reduced blood alkali, a lowered metabolism, a subnormal temperature, a cold skin moist with sweat, a pallid or grayish or slightly cyanotic appearance, also by thirst, shallow and rapid respiration, often by vomiting and restlessness by anxiety changing usually to mental dullness and lessened sensitivity.'

## TERMINOLOGY

Cowell (7 and 8) divided traumatic shock into primary and secondary wound shock. The former condition supervenes immediately when the damage sustained by the body is great and death often results unless prompt treatment is possible. Primary shock is much

less common than secondary traumatic shock. The latter is the usual shock state which frequently appears after a lapse of several hours. In primary shock the symptoms appear to be the result of a powerful stimulus of nervous tissue which results in a reflex relaxation of the vascular tree. It has been suggested that such shock is more likely to occur in the high-strung, or in those with temperamental instability. It may be similar in nature to the conditions initiating fainting or syncope but persists somewhat longer (4 and 18). Modern evidence seems to prove that secondary shock is initiated and due principally to a toxic factor which increases the permeability of the capillary walls resulting in a decreased blood volume and a falling blood pressure. Because of the rapid loss of blood volume through the capillaries Cannon suggests the term *exsanguia* as being descriptive of the essential state of the circulatory apparatus in shock.

## CONTRIBUTORY FACTORS IN SECONDARY SHOCK

Many observers have emphasized the fact that the toxic agent actually seldom works alone. Among initiating factors (18) there is often some blood loss. Infection may increase the potency of the toxic agent. Likewise exposure to cold because of the tendency to lowered metabolism and lowered temperature of the body has been found a very important contributory factor. Lack of food and water or water loss by any method whatsoever as perspiration, purging and vomiting may play a role in the reduction of the blood volume (4). Baruch (2) found the oxygen carrying capacity of the hemoglobin lowered. This fact plus a decreased volume flow, a lowered blood pressure and an increased blood viscosity (4) handicaps the internal cellular respiration. An anæsthetic such as chloroform or ether adds to the disturbed metabolism

both before the blood pressure falls and more so afterward. Thus note is to be made of the fact that although a liberated toxin in traumatic shock is usually the chief factor the final condition of the patient is the result of a group of factors. Therefore improvement may follow when some easily controllable condition is eliminated as for example cold.

#### SUSTAINING FACTORS IN SECONDARY TRAUMATIC SHOCK

After the occurrence of the initiating factors of secondary shock certain sustaining factors become operative and should receive consideration (18). Chief among these are the low blood pressure, a decrease in blood volume, a fall in body temperature and a reduction of metabolism (4). As a result of these changes there is a decrease in the supply of oxygen to the tissue with a tendency toward disintegration (18). Theoretically therefore provided the factors just mentioned continue to be operative the injury to the capillary endothelium becomes more marked and the exudation of the blood plasma continues causing a progressive reduction of the volume of the available circulating fluid of the body. As Cannon has said a series of vicious circles are probably started dependent upon retarded blood flow, lowered metabolism and increased blood viscosity. Krogh (5) has shown that an anoxemia produces capillary relaxation in event which of itself would seem capable of decreasing the available circulating fluid of the body without the aid of the progressive exudation of the blood plasma which seems to be so important as a final factor in secondary shock. All of the deranging processes take an appreciable period of time for their operation and finally end in death unless the vicious circles are broken.

#### RELATION OF SURGICAL TO TRAUMATIC SHOCK

In surgical shock as we see it in ordinary hospital work hemorrhagic toxic agents from infection the harmful effect of anesthesia (especially if it be ether or chloroform) and loss of water from the body by sweating or preparatory purging, all may be more or less operative. Dale (9 and 11) in his work on

histamine shock has shown that in the unanesthetized animal 10 milligrams of histamine per kilo is without marked effect while on the other hand etherization with open mask for hours renders the animal very susceptible to small doses of this toxin. Ether alone may act in such a way as to increase the capillary permeability (4). A somewhat lowered blood pressure is a result to be expected (30) when the effects of ether are added to those of tissue damage. The larger the amount of tissue damage the greater the likelihood of definite shock symptoms.

In abdominal operations as soon as the incisions are handled there is a vasodilation with distention of the capillaries and veins due possibly to local inhibition of vasomotor tone to a change in intra abdominal pressure to venous obstruction or possibly to all of the factors working together. The stasis or lessened return of available fluids to the circulatory tree due to such sequestration of blood during and after abdominal surgery even without blood loss may occasionally explain the occurrence of shock like symptoms. It is obvious that such a vasodilation of the portal vessels decreases the available blood volume and interfere with the return of blood to the heart which in turn decreases the blood pressure and the volume flow of blood to the outlying tissue. Erlanger and Gaser (14) produced shock experimentally by retarding the return of venous blood to the heart. Thus traumatic shock and shock following abdominal operations may be very much alike although the initiating factors and sustaining factors may differ somewhat.

#### OUTLINE OF SHOCK TREATMENT

Because of the vicious circles which are soon established the treatment of severe shock has not been satisfactory. The obvious points of attack have been first to correct as quickly as possible all of the contributory or initiating factors by giving rest, opiates, applying heat, stopping fluid loss and preventing if possible toxic absorption from damaged tissue. The absorption of toxic protein products from damaged tissue has been prevented by excision of such tissue. The sustaining factors have been attacked by attempting to increase the

blood volume the blood pressure, and the volume flow of oxygenated blood to the outlying tissues and also by preventing a continuation of the toxic absorption.

As a preventive measure in shock, Cormoley and Kotzareff (6) have attempted to immunize animals against the shock toxin by previous injection of blood and serum of shock animals but without conclusive results.

Crystalloid solutions such as salt solution, Ringer's solution and glucose solution have been tried repeatedly both in isotonic and hypertonic strengths. During the war colloidal solutions such as gum acacia (3) were added to crystalloid solutions with results not particularly satisfactory. Sodium bicarbonate was given a trial by Cannon, Fraser and Crowell (5) but without good effect. Blood transfusion given slowly seems at present to be the best intravenous treatment although its value is by no means certain especially in extreme cases. Hanzlik and his collaborators (2) have given some evidence that citrated blood is harmful to the organism in concentrated solutions causing certain definite histological changes in the lungs. Considerable evidence is accumulating that our common intravenous preparation which we have used so freely and often without entire knowledge of the actual effect it was having on the blood corpuscles, plasma and the tissue of the body in general may be sometimes actually harmful (12, 13, 20, 21, 2, 24).

Robertson and Bock (9) have given some interesting evidence that in cases of reduced blood volume fluids administered by way of the alimentary tract are to a high degree retained in the circulation. The remarkable feature of their results is the increased volume of fluid held in the blood vessels when water and salt solutions enter the body by natural channels as compared to injected solutions.

Theoretically crystalloids such as glucose and salt even when introduced slowly and in hypertonic strengths would be expected to cause only a temporary rise in blood pressure unless the vicious circles of shock are in some way interrupted by the introduction. The crystalloid molecule (28) is smaller than the colloid molecule and has a higher osmotic pressure. It might therefore be expected to

pass readily out of the circulation since the damaged capillary walls in shock are already permitting the passage of the larger molecules of the colloidal blood plasma. Immediately after the introduction of a crystalloid solution because of its relatively high osmotic pressure some fluid may be drawn from the tissue spaces into the circulation. However the small crystalloid molecules very quickly pass through the capillary wall and an osmotic balance is struck between the outside of the capillary wall and the inside after which substantially the same condition exists as before treatment. Even if the crystalloid did not strike an inside outside balance so to speak it would probably pass off through the kidneys as crystalloids will pass through the kidneys as long as the blood pressure is above 40 millimeters of mercury. Thus crystalloid solutions including glucose and chloride solutions have generally been ineffective in the treatment of shock.

Although the osmotic pressure of a colloidal solution is not as high as that of a crystalloid solution the larger molecules of the former might find difficulty in passing out through the interstices of the capillary endothelium and thereby aid in maintaining the blood volume and pressure. The use of gum salt solution of Bayliss (3) and the glucose acacia solution of Erlanger (14) are attempts to hold fluid in the circulatory tree by combining the high osmotic pressure of a crystalloid with the large molecule of an innocuous colloid. Bayliss as late as 1919 warmly defended his solution as having some value and other favorable reports of its usefulness have appeared (15). Clinical experience with the solution of Bayliss and the solution of Erlanger has not been entirely satisfactory and there have been reported fatalities (5 and 6) due to these solutions. Certainly on the whole the hope held out originally for solutions containing mixtures of crystalloids and colloids has not received universal encouragement.

More recently Kruse (24) and Hanzlik and Karsner (1) have presented new evidence which now must be taken into consideration when any intravenous solution is used. Hanzlik and his associates have found that gum acacia apparently produces rather definite

physical and chemical changes in the blood. Among the change that may occur after the intravenous injection of such colloids as gum acacia and various hypertonic solutions of crystalloids in the concentrations that have been used in clinical work are hæmaggglutination, hæmolyis, darkening and rapid sedimentation of the blood, lowering of the hydrogen ion concentration, increase of lactic acid and a diminution in carbon dioxide content of the blood. Of obvious striking importance are changes observed in the hæmoglobin and red blood corpuscle followed sometime by the occurrence of minute pulmonary emboli with capillary thrombosis and extracapillary hemorrhage in the lungs. The blood pressure and respiration change were also apparent. More recently Appleman (11) has compared the effect of 5 per cent acacia on the viscosity of oxalated blood and sedimentation of corpuscles *in vitro* with the change in the physical factors of the blood after intravenous injection in rabbit. He confirms alterations in the blood as found by Hanzlik. The viscosity of the blood increased. At times the blood was so thick that it viscidity could not be measured. The rapidity of centrifugal sedimentation was greatly increased. Control solution of sodium chloride however produced no such effect. Finally Hanzlik and Kurnachev have shown that many agents among which was acacia in the concentration which has been used in the treatment of shock and hemorrhage agglutinate red blood cells *in vitro* indicating a basis for preliminary embolic and other histological evidence of lung injury. Foster and Whipple (17) have noted that intravenous injection of acacia delayed return of the fibrin content of the blood to its normal value and that clottings delayed or prevented. The latter fact is of importance when contemplating the use of gum acacia solutions in uncontrolled hemorrhage. Cessell (19) warns that the greatest care should be used in the use of blood substitutes in man. In his experience toxic effects with a fall in blood pressure were not an unusual occurrence.

#### GLUCOSE INSULIN IN SHOCK

In a recent paper Fisher (16) has advocated the use of glucose and insulin in the

treatment of shock. His conception of shock and its rational treatment is based upon the following statement. Our conception of shock is that in this state an internal asphyxia and acidosis with oxidation processes held in check or abeyance result in a state of exhaustion. I personally believe that this state is primarily caused by a sudden derangement of the central nervous system. Whether these two conceptions are correct or not any method promoting combustion and oxidation and at the same time furnishing heat energy should be effective in combating shock. Fisher suggested that insulin might serve to increase the rate of oxidation of glucose in the tissue and aid in supplying carbohydrate or food and oxygen in some manner to the injured and anoxic cell—thus aiding in combating the injurious effects of the toxin which is thought to produce shock. After a review of the literature concerning our present knowledge of the fate of glucose after insulin injection no reason was obvious to us why glucose inulin should act more beneficially in shock than a hypertonic solution of the crystalloid glucose without the addition of insulin. Fisher mentions 31 cases of shock treated successfully with glucose and insulin and records in detail 5 typical cases. Two of these cases he regarded as toxic or septic shock. We wonder if such cases should be classified with traumatic shock since they present factors not found in this condition.

In an effort to aid in establishing the true value of glucose and insulin in the treatment of traumatic shock we have carried out a series of experiments upon dogs.

#### EXPERIMENTAL RESULTS

Each dog was anesthetized with ether. After the first few minutes of anesthesia very little ether was required to keep the animal quiet. The carotid artery was connected with a mercury manometer and the blood pressure readings were recorded on kymograph paper. Shock was produced by hammering the thigh muscles of one leg followed by occipital massage until the blood pressure fell below 70 millimeters of mercury with a definite tendency for the fall to continue. After this state was produced treatment was begun.

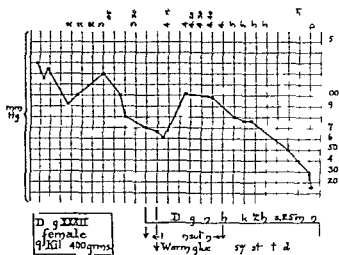


FIG. 1. Chart showing the blood pressure changes in experimental shock treated with glucose and insulin.

Fourteen of the dogs were treated with glucose and insulin (Lilly). The latter was used in a dosage of approximately 1 unit of insulin for every gram of glucose given. The insulin was given subcutaneously before the introduction of the glucose in some animals and in others 10 to 30 minutes after the glucose was started. In a few experiments the insulin was given very slowly with the glucose by the intravenous method.

In all but one of the dogs there was a rise in the blood pressure almost immediately following the administration of the hypertonic solution. The usual response was a rise to 80 or 90 millimeters of mercury. As a rule this level was maintained from 15 to 30 minutes after which the pressure slowly fell and usually continued to fall steadily until the animal died from 1 to 4 hours after treatment was begun. In no case did an animal recover completely although one recovered a blood pressure of 100 and lived from 2:45 p.m. until midnight or 9 hours and 15 minutes.

Six animals were treated with glucose alone to control the glucose-insulin treatment. The blood pressure readings in this series differed very little from those in the series receiving the insulin.

Shock was produced in the same manner in 12 dogs used as controls and progress was noted until death. The rapid fall in blood pressure with a continued low pressure until the end of the experiments corresponded very

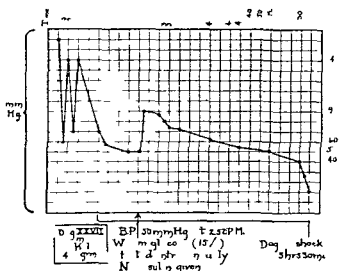


FIG. 2. Chart showing the blood pressure changes in experimental shock treated with glucose and insulin.

closely to the change in blood pressure of the animals treated. Death occurred from 1 to 1 hour earlier than in the treated series. The transitory rise in pressure after the glucose was given of course was absent in the controls.

Finally, as further controls 2 dogs were treated with 1 per cent glucose-insulin and 15 per cent sodium chloride solution. In one animal the glucose-insulin was given until the blood pressure fell to a critical level at which time the sodium chloride solution was substituted. In the other animal the procedure was reversed. The change from one crystalloid solution to another gave a slight temporary rise in blood pressure for a few minutes (a rise of about 10 millimeters of mercury) after which time the manometer reading fell as before the change of solutions.

In no instance was any evidence noted that the addition of insulin in any way caused any specific aid that could be determined by change in blood pressure or general condition of the animal. Glucose alone in 6 animals acted as favorably as the glucose-insulin combination. The hypertonic sodium chloride solution temporarily elevated the blood pressure similar to the glucose or glucose-insulin solution.

Several times during the production of the shock state the blood pressure would spontaneously recover after being below 70 millimeters of mercury from 10 to 20 minutes. Thus it is to be noted that any treatment



instituted before the tendency toward a falling pressure was definitely established might appear to be of value

In two dogs intravenous 15 per cent glucose given at the rate of 5 cubic centimeters per minute apparently caused a change in the hemoglobin. The blood withdrawn after death in the e cases was chocolate colored. This seemed to us sufficient evidence to warn against giving very rapidly glucose solution in this strength.

#### SUMMARY

1 In the interpretation of shock treatment it must be remembered that mild cases often recover either with or without the use of the common intravenous solutions. Before an estimate is made as to the value of any special method it must be definitely determined that the condition dealt with is really shock.

Hypertonic solutions of crystalloid have not been used with complete success in the past in the treatment of well developed shock. Recently evidence is accumulating that intravenous therapy with hypertonic solution of crystalloid unless introduced with the greatest care may be actually harmful.

3 From the experimental standpoint the glucose-insulin treatment of shock recently advocated by Fisher seems to be no more beneficial than treatment with a hypertonic solution of glucose or sodium chloride.

4 Further studies should be made to learn if possible whether a patient in the true shock state can utilize glucose with insulin as do normal individuals or patients suffering with other diseases.

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DEFENSIVE FACTORS IN CARCINOMA OF THE BREAST<sup>1</sup>By PAUL C. FLOTHOW, M.D., ROCHESTER, MINNESOTA  
I l l w S g y Th M j I d

UNTIL recently it has been practically impossible to give even a fairly accurate prognosis in any form of malignant disease. A consideration of the defense reaction against carcinoma led MacCarty in 1910 to observe the presence of lymphocytic infiltration, fibrosis, and hyalinization around carcinoma cells in the breast and also the differentiation of these cells. He later applied the presence or absence of these factors in prognosticating the postoperative length of life. On this basis Broders in 1919 made a fairly accurate prognosis possible in cases of epithelioma, his prognostic data being based on a system of grading the degree of malignancy of these growths according to the relative degree of differentiation present.

## LITERATURE

Most of the literature on the subject of defensive factors in carcinoma of the breast is the result of the work of MacCarty and Broders. In 1922 Sistrunk and MacCarty published a paper based on the study of 18 breasts which had been radically removed for carcinoma. The study was both pathological and clinical. They found that the greatest combined factors in longevity were cellular differentiation and hyalinization and that cellular differentiation, hyalinization, and fibrosis are the greatest single factors.

Again in 1922 MacCarty in a further study stated that when any of the factors are present postoperative life is increased and increased most when differentiation and hyalinization are present. He stated that the uniform consistency of increased length of postoperative life in the presence of the defensive factors suggests that they play a significant role as a part of the natural defensive mechanism against carcinoma.

Later in 1927 MacCarty studied 9 cases of carcinoma of the breast in which death had occurred. He found that in the presence of fibrosis postoperative life was increased 34 per cent and 40 per cent in the presence of

hyalinization and that when both were present postoperative life was increased 56 per cent.

In 1934 in studying the prognostic value of the four factors he found that whenever the factors are present the average length of life is greater than when they are absent and that this is true of all four factors. He also found that the variation in the frequency of the presence of the factors in different organs suggests that the defense mechanism probably acts differently in different organs.

## MATERIAL AND METHOD

This paper is based on the study of 300 breasts which had been radically removed because of carcinoma. For various reasons only 222 were suitable for inclusion in the statistics. I examined every gross specimen and cut blocks from carcinomatous areas for microscopic study. All of the data have been checked by questionnaires. The living patients have been alive from 5 to 10 years without any evidence of recurrence. In all of the cases studied in which the patient died death occurred within 5 years of the operation and in every case it was due to recurrence or metastasis. The cases were divided into the following groups: (1) those cases in which the axillary lymph nodes were involved the patient being alive after 5 years with no evidence of recurrence or metastasis and (2) those in which the lymph nodes were not involved but death occurred within 5 years. These two groups were studied comparatively in order to determine the relative frequency of the factors in these two extremes. For comparison the following groups were also studied: (1) those cases in which the lymph nodes were involved but death occurred within 5 years and (2) those in which there was no involvement of lymph nodes and the patient is living without evidence of recurrence or metastasis.

Throughout this paper all references to involvement of lymph nodes refer to findings

# SURGERY GYNECOLOGY AND OBSTETRICS



0 Diff r ti ti



1 Diff ti ti



2 Diff ti ti



3 Diff ti ti

f h d f f h l d f f t t l d the  
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the time of operation. When the number year is stated it indicates the interval since operation.

It is well known that in many cases of carcinoma of the breast in which lymph nodes were not involved at operation the patient lives many years after without any sign of recurrence or metastasis. It is equally well known that in many cases in which only a small localized carcinoma is found without involvement of lymph nodes or evidence of metastasis the patient dies within a few months. It has been my aim in this study to find out if possible why this should be true. A clue to the answer may be discovered in MacCarty's work. If it is true that there is a definite defense mechanism then it should rather be true that this defense mechanism would be well developed in those patients who recover in spite of involvement of lymph nodes and that on the other hand cases of fatal carcinoma in which the lymph nodes were not involved should be characterized by a poorly

The defensive factors dealt with in this study are the same as those observed by MacCarty namely differentiation fibrosis hyalinization and lymphocytic infiltration and the same definitions for the terms are used.

There is some doubt as to the correct position which cellular differentiation should occupy. It may be an inherent characteristic of the growth itself or it may be due to factors in the surrounding tissues which allow differentiation. At first thought cellular differentiation might naturally be considered as a characteristic of the growth and not connected with nature's defense but this is apparently not the case. Differentiation of cells in nature is the result of adaptation to favorable environment. It is possible that this is also the case with malignant cells. It is thought that the favorable environment is the property of the organism rather than of the cell itself and for this reason differentiation is placed among the body's defense factors. However it is considered to be an index of the defensive mechanism rather than a specific defensive factor.

The microscopic sections were divided into three groups, those in which differentiation was absent or minimal, those in which the tendency to differentiate was distinct but not marked, and those in which the tendency to differentiate was marked (Fig. 1). Before the results were consolidated Group 2 and 3 were combined so that the classification was based merely on the presence or absence of cellular differentiation. It is felt that this must play a very definite part and that a growth which is well differentiated should support a better prognosis than one which is not.

There was a distinct tendency to differentiate in about 65 per cent of all cases. The higher the degree of differentiation the more the growth resembled normal gland. In highly differentiated growths it was quite commonly found that none of the other defense factors was present (Figs. 2 and 3).

In the study of fibrosis the main difficulty was in determining in just what case fibrosis should be called a factor of defense and when

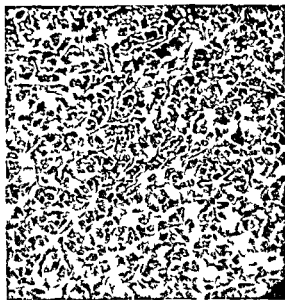


Fig. 2 An entirely undifferentiated growth with no defensive factors present

tissue *per se* were to be taken as a positive criterion fibrosis would be present in every case since there is a certain variable amount of fibrous tissue present in every case. In the normal fibrous tissue the fibrils present a characteristic interlacing pattern. Fibrosis due to malignancy however is in much more intimate relation with the cells. The fibrils form a barrier around the masses of cells which is quite different from the arrangement in normal fibrosis. The same question of degree was met with here and dealt with just as in the case of differentiation (Fig. 4).

The same statements made in regard to fibrosis are applicable to hyalinization since hyalin develops from fibrous tissue. When hyalinization is marked there is little pure fibrosis since the former is merely hyalinized fibrous tissue. Of all the factors hyalinization is found in the smallest percentage of cases probably because it is the last factor to appear. It was present in only about 30 per cent of the cases. Because of the firmness which characterizes it hyalinization is the most effective of the tissue factors since it constitutes a practically impossible barrier to the advance of malignant cells.

Lymphocytic infiltration is the least important factor however it is the first to appear. It is characterized by a dense wall of small lymphocytes intimately surrounding



Fig. 3 Highly differentiated tumors. The cells are of a much more mature type than those in Figure 2. Nucleoli are not prominent and cells are placed in definite acinar groups. Here also there is very little defensive reaction.

the cancer cells which may be many cells in thickness (Fig. 5).

It was frequently found that when the degree of cellular differentiation was very high there was little if any other defensive reaction. Frequently one factor such as fibrosis or hyalinization was also present to a marked degree while no other factors were present. The degree to which any factor is present undoubtedly plays an important part but as it was difficult to evaluate it it is not included in the statistics.

#### DATA

In 88 cases the lymph nodes were involved and the patient lived more than 5 years without recurrence or metastasis. In 6 of these cases (3 per cent) all factors were present in 87 (98.8 per cent) one or more usually more factors were present. In only 1 case were all of the factors absent. In this group as a whole considering four factors for every case as 100 per cent the percentage of factors present was 70 and the percentage of



Factors absent was 30. This gave an average of about three of the four factors present in each case.

In 33 cases the glands were free from involvement but the patient died (Group 1). In 11 cases (33 per cent) none of the factors was present. In only one case were all four factors present. Taking this group as a whole 86.5 per cent of the factors were absent and only 6 per cent were present. This was an average of only one factor for each case whereas in the former group there was an average of three (Table I) as exemplified in such tumor as that illustrated in Figure 6.

Early in this paper it was stated that if the so-called defensive factors were of any value it would be shown in the two groups. It was anticipated that in cases such as those in Group 1 the factor should be well defined and that in such case as those in Group 2 the factors should be poorly defined. Analysis of Table I shows that this is very definitely the case.

Comparison of the total incidence of the factors in the two groups shows that the defense mechanism was almost three times as manifest in Group 1. In Group 1 all four factors were present in 23 per cent or about one fourth of the cases while in Group 2 3 per cent of the cases or only 1 case in the 33 had all four factors present.

In Group 1 only in 1 per cent of the cases were there no factors present while in Group

TABLE I—COMPARISON OF GROUPS 1 AND 2

	Group 1				Group 2			
	Lymph	Hy	Fib	Def	Lymph	Hy	Fib	Def
Cell	1	1	1	1	1	1	1	1
Cell	1	1	1	1	1	1	1	1
Fib	1	1	1	1	1	1	1	1
Hy	1	1	1	1	1	1	1	1
Def	1	1	1	1	1	1	1	1
Lymph	1	1	1	1	1	1	1	1
Lymph	1	1	1	1	1	1	1	1
All	1	1	1	1	1	1	1	1
All	1	1	1	1	1	1	1	1
T	1	1	1	1	1	1	1	1
T	1	1	1	1	1	1	1	1

all factor was absent in 33 per cent. In Group 1 there were defensive factors in practically every case while in Group 2 there was absolutely no defense reaction in one third of the cases.

On further analysis of Table I it will be seen that cellular differentiation was about three times as common in Group 1 as in Group 2 being present in the former in 86.5 per cent of the cases and in the latter in only 33 per cent. Fibrosis was present in about the same ratio 86.5 per cent in Group 1 and 36 per cent in Group 2. The preponderance of hyalinization in Group 1 is even more marked; it was present in 55 per cent of the cases in Group 1 but in only 9 in Group 2. Lymphocytic infiltration was twice as common in Group 1—52.5 to 27 per cent. Not only were the factors as a whole much more common in Group 1 but each individual factor was much more common in Group 1 than in Group 2.

Fifty cases were studied in which the lymph nodes were free and the patients were still alive (Group 3). This group is not very distinctive as in view of the early removal of the carcinoma the prognosis should be fairly good irrespective of the presence or absence of the factors. In 6 cases (12 per cent) all the factors were present. In 3 cases (6 per cent) all were absent. In the entire group 61.5 per cent of the factors were present and 38.5 per cent were absent.

Fifty one cases were studied in which the lymph nodes were involved and the patients were dead (Group 4). This group also is not very distinctive as the involvement of lymph nodes with or without the defensive



Fig. 5 Shows the lymphocytic infiltration around the cancer cell



Fig. 6 Three factors are present hyalinization and fibrosis are shown in upper half of the field and lymphocytic infiltration in lower left

factors generally entailed a poor prognosis. Of this group in 24 per cent no defense factors were present and in 4 per cent all four factors were found. In this group as a whole 61.3 per cent of factors were absent and 38.7 per cent were present. Even here there was a marked preponderance of missing factors.

#### SUMMARY

Of the 300 specimens of carcinoma of the breast which were studied for various reasons only 222 were suitable for inclusion in the statistics. The study was confined to the four defensive factors: cellular differentiation, fibrosis, hyalinization and lymphocytic infiltration. The study was undertaken with the idea of proving or disproving their defensive nature. They were found to play a distinct part in retarding the growth and spread of carcinoma. The various factors

are discussed individually and observations on their characteristics are made.

In the 88 cases in Group 1 (the case in which lymph nodes were involved but the patient was living more than 5 years after operation) 70 per cent of the defensive factors (an average of approximately three of four factors) were present. In 3 per cent of the cases all factors were present. In the 33 cases in Group 2 (the case in which the lymph nodes were free but the patient had died within 5 years) only 6 per cent of the factors were present, an average of only one of the four in each case. In 33 per cent of the cases none of the factors was present and in only 1 case were all the factors present. There was also a marked preponderance of the individual factors present in Group 1, most marked in the case of hyalinization which was present in 55 per cent of the cases in Group 1 and in only 9 per cent of the cases in Group 2.

In the 50 cases in Group 3 (lymph nodes free and patient alive) factors were present in 61.5 per cent of the cases and absent in 38.5 per cent.

In the 51 cases in Group 4 (lymph nodes involved and patient dead) factors were absent in 61.3 per cent of the cases and present in 38.7 per cent, just reversing the figures of the previous group.

TABLE II — COMPARISON OF GROUPS 3 AND 4

	C Lymph p	P 3 od t t	G Lymph p	P 4 od t t
Cellular differentiation present	84		51	
Cellular differentiation absent	16		49	
Fibrosis present	80		40	
Fibrosis absent	0		51	
Hyalinization present	46		17	
Hyalinization absent	54		83	
Lymphocytic infiltration present	36		36	
Lymphocytic infiltration absent	64		64	
All factors present	1		4	
All factors absent	6		4	
Total per cent of factors present	61.5		38.7	
Total per cent of factors absent	38.5		61.3	

## CONCLUSIONS

1. The preponderance of evidence indicates that cellular differentiation fibrosis hyalinization and lymphocytic infiltration are nature's defensive mechanism against carcinoma.

While the cancer doubt are not the only means of defense they are probably the most important.

They play a definite and distinct part in retarding the growth of carcinoma in the breast.

4. They are not present in every case and vary considerably in degree and thus in effectiveness.

If following amputation in a case without involvement of lymph node all the defensive factors are found present a good prognosis is justified if they are not present the prognosis is not so favorable.

6. If in a case with involvement of lymph node there are no factors present the prognosis is poor. If all the factors are present it is still not good but certainly better.

The results emphasize more than ever the necessity of early diagnosis and radical amputation for carcinoma of the breast.

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## GALL-BLADDER DISEASE IN YOUNG SUBJECTS

BY ALFRED H. POTTER, M.D., SPRINGFIELD, OHIO

THE incidence of gall bladder disease in adolescents and patients under middle age has always been considered as very rare by most medical writers. Moreover a perusal of standard works on pediatrics including the latest and best textbooks written in the most interesting and presumably the most instructive way would give one a wrong impression upon this subject and would rather suggest that they cannot be based upon actual experiences outside of that of the authors since they hardly mention anything in reference to gall bladder disease in children or at least imply that gall bladder disease is a matter of but slight importance in childhood and adolescence. The writer's personal experience and study of the literature has however led him to a quite different opinion and it is the purpose of this paper to show with the help of collected data that gall bladder infections occur most frequently in adults under middle age and that such diseases including the occurrence of biliary calculi may be met quite often in adolescents and young children.

The writer has within the past 3½ years personally observed 4 verified cases of gall bladder disease in patients not over the age of 15 years the histories of which are given at the end of this report. This fact was so unusual and so much at variance with the accepted ideas on the subject that the writer was led to investigate the literature of the age incidence of gall bladder disease with special reference to infants, children and young adults. This investigation appears clearly to establish the statement already made that gall bladder disease is much more prevalent in young subjects than has hitherto been commonly believed and furthermore that as regards the age incidence in diseases of the gall bladder and biliary passages a restatement of our more exact knowledge and a correction of the misstatements upon which our beliefs in the past were based would appear to be absolutely essential.

To prove my contention that gall bladder affections are found in patients under middle age of life more frequently than believed in the past I will quote as follows. In a series of 59 operations on the gall bladder it was found that in over 15 per cent of the cases the patient was under 30 years of age.

Mann and Wilson (77) in a study of 57 cases of chronic gall bladder disease in young adults operated on in the early stages of the infection found that more than 90 per cent were under 35 years of age.

Starr also states that in over 36 per cent of cases under observation there was a history of biliary attacks before the age of 25 years.

## STATISTICAL DATA

A study of statistics of something like 5,000 cases of gall bladder disease collected from the reports of well known clinics and hospitals shows the average age of patients at time of operation to be for females 36 years and for males 39 years. Although the duration of symptoms varies greatly the study further shows that for females the symptoms last from the time of onset to the time of operation for an average of 6 years and for males 5 years.

The shortest and longest duration from the time of onset of symptoms to the time of operation were 3 hours and 59 years respectively. Of course many factors intervene in regard to the time when patients seek surgical relief from their suffering. But the figures would apparently prove that the age of incidence of gall bladder disease is on the average 30 years in the case of females and 34 years in the case of males. This is to say that judged from the statistics one must believe that gall bladder infections begin to give symptoms in the most active period of life and then place the average age incidence far below that generally accepted in the past.

With regard to the occurrence of gall bladder disease in very young subjects beginning with the case published by Gibson (58)



## CONCLUSIONS

1. The preponderance of evidence indicates that cellular differentiation fibrosis hyaline infiltration and lymphocytic infiltration are protective mechanisms against carcinoma.

While there is no doubt they are not the means of defense they are probably of important importance.

They play a definite and direct part in retarding the growth of carcinoma.

4. They are not present in every carcinoma in degree in effectiveness.

In following amputation without involvement of lymphatic system the defensive factors are found to be present in the prognosis is not so favorable.

6. If in a case with involvement of lymphatic node there are no factors of defense the prognosis is poor. If all the defensive factors are present it is still not good but.

7. The following factors are presented in the literature: claims that carcinoma is caused by gall stones. When the stone is present there is a definite diagnosis.

8. GALL STONES IN THE BLADDER. It is stated that gall stones in the bladder are the first decade of the second. It is also frequently seen prior to that afterward they are common with advanced carcinoma.

9. Autopsy of gall stones in the bladder. Every year an and found after death how many of these.

10. I thought that at least one of the cases upon whom he had been operated for gall stone were of advanced age.

11. It is impossible from the collected evidence to determine definitely at just what age calculi are formed but review of the literature has shown that such calculi are not found at all ages from that of a fetus to a patient aged 86 years.

## LOGICAL CONSIDERATIONS REGARDING GALL BLADDER DISEASE IN YOUNG SUBJECTS

Certain etiological considerations would appear to support the occurrence of gall bladder disease in young subjects.

In the past it was fairly accepted as a fact that typhoid fever was generally the preceding etiological factor in gall bladder disease but in recent years and at the present time it is accepted that other pathological conditions such as influenza appendicitis scarlet fever diphtheria etc. in the order named can be preceding factors.

Medical literature shows a great decrease in the number of typhoid cases in the past few years and if this decrease continue typhoid will be practically eliminated.

The twenty fourth annual report of the U S Census Bureau shows a very great decrease in death from typhoid fever even in the face of an estimated population increase. But this report also shows a great increase in deaths from influenza and from the fact it is my belief that influenza is supplanting typhoid as the preceding etiological factor in gall bladder disease.

The diseases which have served the gall bladder as factors but which can be traced to the play of the young.

It is important if to the young man with infectious disease.

of the gall bladder has been positively demonstrated. A small number of cases which resembled mild pernicious anemia possessed the same type of biliary infection and upon its removal the patients were restored to fairly normal health.

Digestive tract infections no matter how they originate must be considered the most probable origin of gall bladder infections in the very young but this presumes a stagnation of the gall bladder.

In cholecystitis stagnation of the bile in the gall bladder is the main predisposing cause of infection. Hence the stagnant gall bladder may almost assume the importance of a clinical entity.

The gall bladder should not be viewed as an actively functioning organ that rhythmically fills and empties itself under the stimulus of digestion. An enormous concentration of bile in the gall bladder takes place with the addition of a mucous element. As stated by Mann (76) the most recent investigations have proved that the gall bladder has at least one function viz concentration of the bile and plays a role in the regulation of intrabiliary duct pressure. But the flow of bile originates in the liver and sweeps down through the ducts into the duodenum dis regarding in the main part the gall bladder and variations in the bile flow and concentration occur in the liver in answer to the various degrees of food stimuli (7).

The gall bladder as an active organ does not seem to enter into the physiology of the bile excretion the outflow from the gall bladder appearing to be in the nature of an overflow incontinence.

Because of the small amount of smooth muscle in the wall of the gall bladder it is probably more correct to say the gall bladder evacuates rather than contracts.

Hydrops may be a condition affecting gall bladder stagnation. As pointed out by Kehr (66) hydrops may be transitory or permanent. Acute infections of the gall bladder and cystic duct of a mild character usually are accompanied by hydrops. With the subsidence of the inflammation the cystic duct recovers its function drainage of the gall bladder occurs and the hydrops disappears. Heister's valves

are swollen because of oedema of the mucous membrane of the cystic duct and this may be the cause of the already described condition. It is stated that a constriction of the sphincter of Oddi may be the cause of the same condition. But the most important factor controlling the overflow of bile from the gall bladder and biliary passages is the motility and tonus of the duodenum as pointed out by Burget (12).

I wish to report the 4 following cases of interest coming under my personal observation in the past 3½ years.

CASE I September 4 1923. A well nourished boy aged 11 years had abdominal pain and vomiting for 5 days before examination. The only previous illness was measles at the age of 6 influenza at the age of 10. The patient had had dizzy spell and vomiting several times during the past year. His skin was slightly jaundiced. He was drowsy without opiate. The right side of the abdomen was rigid and tender with marked tenderness inches to the right and upward from the umbilicus tenderness over McBurney's point distention and tympanic abdomen especially in the epigastric region very marked tenderness on palpation just below the twelfth rib in the midaxillary line on the right side. The temperature was 10.4 degrees F pulse rate 106 respiration 44. The blood count showed leucocytes 3400 polymorphonuclears 94 per cent. Urinalysis was practically negative. A provisional diagnosis of acute appendicitis and acute cholecystitis was made. A laparotomy was performed that same night and showed a moderately inflamed elongated high placed appendix kinked and adherent at its mid portion and its distal end adherent in the region of the common duct. The latter was inflamed and thickened. Exploration of the gall bladder revealed a greatly enlarged oedematous organ (hydrops) under great pressure. The wall was of a grayish color. It contained 178 cubic centimeters of mucus which was bile streaked at the end of aspiration. The gall bladder was opened and explored no stones were found. With some difficulty water was forced through the ducts the gall bladder was swabbed out with gauze and a rubber tube drain inserted. Pathological findings indicated that the condition was a subacute appendicitis. Culture of bile gave no growth. The patient had an uneventful recovery after appendectomy and cholecystostomy.

Postoperative notes. The discharge of mucus through the drainage tube stopped on the sixth day after operation then bile escaped from that time on. The jaundice cleared up in 9 days after operation. The temperature was not normal until 10 days after operation. On March 17 1927 3½ years after the operation was performed the patient was in excellent health.

in 1922 and including cases reported up to the end of August 1927 I have been able to collect 226 cases in this period in children. This number would I am sure be greatly increased if all observed cases had been reported. The review shows that pathological condition of the gall bladder or ducts were observed in children under 15 years of age and were diagnosed by the symptoms and verified either by operation or autopsy.

An outstanding feature in this review is that the colored race is far less frequently affected with gall bladder disease than the white race. Another matter as regards the symptoms is that while in many cases the symptoms in children were typical as in adults yet children are rather inclined to complain of abdominal pain when gall bladder disease is present because they are apt to refer most pain to the abdomen. Indeed in adults many symptoms of cholelithiasis which are classified vaguely as stomach and liver troubles biliousness indigestion dyspepsia etc. will be found in such a history and will often lead to the diagnosis of biliary calculi before marked symptoms have presented themselves. Riedel (110) claims that "cramps in the stomach are caused by gall stones in 97 out of 100 cases. When the so-called classical symptoms are present there is little difficulty in making the diagnosis."

#### THE OCCURRENCE OF GALL STONES IN YOUNG SUBJECTS

It is still believed by many that gall stones practically never occur during the first decade of life and but rarely in the second. It is also believed that they are infrequently seen prior to the thirtieth year and that afterward they become progressively more common with advancing years.

In more than 9000 autopsies gall stones were found in 1 case in every 30 by Naunyn (93) in persons past 60 years.

It is stated by Hektoen and Pie man (60) that biliary calculi are found in 25 per cent of all cadavers at autopsy after the sixteenth year. It has been stated however that gall stones in patients under 35 years of age are quite unusual. With this statement the writer does not agree.

Matheys (81) thought that at least one half of the patients upon whom he had been called upon to operate for gall stone were under 30 years of age.

It is quite impossible from the collected statistics to determine definitely at just what age biliary calculi are formed but review of the literature has shown that such calculi have been found at all ages from that of a 6 month fetus to a patient aged 86 years.

#### ETIOLOGICAL CONSIDERATIONS REGARDING GALL BLADDER DISEASE IN YOUNG SUBJECTS

Certain etiological considerations would appear to support the occurrence of gall bladder disease in young subjects.

In the past it was fairly accepted as a fact that typhoid fever was generally the preceding etiological factor in gall bladder disease but in recent years and at the present time it is accepted that other pathological conditions such as influenza appendicitis scarlet fever diphtheria etc. in the order named can be preceding factors.

Medical literature shows a great decrease in the number of typhoid cases in the past few years and if this decrease continues typhoid will be practically eliminated.

The twenty fourth annual report of the U. S. Census Bureau shows a very great decrease in deaths from typhoid fever even in the face of an estimated population increase. But this report also shows a great increase in death from influenza and from this fact it is my belief that influenza is supplanting typhoid as the preceding etiological factor in gall bladder disease.

The infectious diseases of children have however not received the attention they deserve as preceding factors in the evolution of gall bladder disease but I think that there can be but little doubt of the important role which these diseases play in infections of the gall bladder and biliary tract especially in the young.

Many conditions are a frequent concomitant if not an etiological factor and according to Jones and Joyce (65) in every case of pernicious anemia they have come in contact with in the past few years a chronic infection

of the gall bladder has been positively demonstrated. A small number of cases which resembled mild pernicious anemia possessed the same type of biliary infection and upon its removal the patients were restored to fairly normal health.

Digestive tract infections, no matter how they originate, must be considered the most probable origin of gall bladder infections in the very young, but this presumes a stagnation of the gall bladder.

In cholecystitis stagnation of the bile in the gall bladder is the main predisposing cause of infection. Hence the stagnant gall bladder may almost assume the importance of a clinical entity.

The gall bladder should not be viewed as an actively functioning organ that rhythmically fills and empties itself under the stimulus of digestion. An enormous concentration of bile in the gall bladder takes place with the addition of a mucous element. As stated by Mann (76) the most recent investigations have proved that the gall bladder has at least one function, viz. concentration of the bile and plays a role in the regulation of intra-biliary duct pressure. But the flow of bile originates in the liver and sweeps down through the ducts into the duodenum. Disregarding in the main part the gall bladder and variations in the bile flow and concentration occur in the liver in answer to the various degrees of food stimuli (7).

The gall bladder as an active organ does not seem to enter into the physiology of the bile excretion; the outflow from the gall bladder appearing to be in the nature of an overflow incontinence.

Because of the small amount of smooth muscle in the wall of the gall bladder it is probably more correct to say the gall bladder evacuates rather than contracts.

Hydrops may be a condition affecting gall bladder stagnation. As pointed out by Kehr (66) hydrops may be transitory or permanent. Acute infections of the gall bladder and cystic duct of a mild character usually are accompanied by hydrops. With the subsidence of the inflammation the cystic duct recovers its function; drainage of the gall bladder occurs and the hydrops disappears. Heister's valves

are swollen because of edema of the mucous membrane of the cystic duct and this may be the cause of the already described condition. It is stated that a constriction of the sphincter of Oddi may be the cause of the same condition. But the most important factor controlling the overflow of bile from the gall bladder and biliary passage is the motility and tonus of the duodenum as pointed out by Burget (1).

I wish to report the 4 following cases of interest coming under my personal observation in the past 3½ years.

CASE 1. September 24, 1923. A well nourished boy aged 11 years had abdominal pain and vomiting for 5 days before examination. The only previous illness was measles at the age of 6, influenza at the age of 10. The patient had had dizzy spells and vomiting several times during the past year. His skin was slightly jaundiced. He was drowsy without opiate. The right side of the abdomen was rigid and tender with marked tenderness 2 inches to the right and upward from the umbilicus; tenderness over McBurney's point; distention and tympanic abdomen especially in the epigastric region; very marked tenderness on palpation just below the twelfth rib in the midaxillary line on the right side. The temperature was 102.4 degrees F, pulse rate 106, respiration 44. The blood count showed leucocytes 23,400, polymorphonuclears 94 per cent. Urinalysis was practically negative. A provisional diagnosis of acute appendicitis and acute cholecystitis was made. A laparotomy was performed that same night and showed a moderately inflamed, elongated, high placed appendix, kinked and adherent at its mid portion and its distal end adherent in the region of the common duct. The latter was inflamed and thickened. Exploration of the gall bladder revealed a greatly enlarged, edematous organ (hydrops) under great pressure. The wall was of a grayish color. It contained 178 cubic centimeters of mucus which was bile streaked at the end of aspiration. The gall bladder was opened and explored; no stones were found. With some difficulty water was forced through the ducts; the gall bladder was swabbed out with gauze and a rubber tube drain inserted. Pathological findings indicated that the condition was a subacute appendicitis. Culture of bile gave no growth. The patient had an uneventful recovery after appendectomy and cholecystostomy.

Postoperative notes. The discharge of mucus through the drainage tube stopped on the sixth day after operation; then bile escaped from that time on. The jaundice cleared up in 9 days after operation. The temperature was not normal until 10 days after operation. On March 17, 1927, 3½ years after the operation was performed, the patient was in excellent health.



## GALL-BLADDER DISEASE IN YOUNG SUBJECTS

N	Age	Sex	Ag	Ch	Ch	Ch	Pathology	Symptom	Diagnosed Also Type of One
7	Gbo	M	1	Yes	N	N	Ascites, M d t G ll bl d d t t led	P t th d g l f	A t r y
75	Coe	L	1	Yes	N	N			A t p y
3	Leut d	M	1	Yes	N	Yes	E l l g e d l g ll bladd d d t	( l i t s e ) l	A p y
4	83	P tal	L	1	Yes	N	L nfiltr ted th blood		A p y
5	83	P t l	L	1	Yes	N	L nfiltr ted th blood		A r y
6	83	I t l	F	1	Yes	N	B l d t s filled h b l y cal l	I r e s d e s t d l	A t p y
7	8	B b y t	M	1	Yes	N			A p
8	8	Be h y t	L	1	Yes	N			A t p y
9	89	Cru lh	L	6	Yes	N		T be los	A p y
89	Cru lh	L	1	Yes	N	N			A r y
8	Ornl	M	1	Yes	N	N	D k gree l l h m		A t y
834	Lol tt	M	1	Yes	Yes	Yes		A t m l f d b l s t p t	A t m t f d (feces)
3	835	H so	L	8	Yes	N	I d p e f f g ll bl ad	T yph d	A o r y
4	838	V ll	L	1	Yes	N			A r y
5	838	V ll	L	1	Yes	N			A p y
6	838	V ll ix	L	1	Yes	N			A t p y
7	843	L so	L	1	Yes	N	C m m u n g l l t t f m m d Th k bl k b l g ll bl d s	A b d m l p l e	A p y
8	85	Ar h mb l	L	1	Yes	N	L f g ll bl d l h l e c y t u s l f t	T yph d l t	A t p y
9	853	Barth Rull t	L	1	Yes	N	R p t e d g ll bladd th l g b c e s s b o t t	T yph d	A t p y
86	T se	F	1	Yes	Yes	N		T yph d l l col	S m p t m s
86	W l d	M	1	Yes	N	N			S m p t m t f d (feces)
89	F ich	F	1	Yes	N	N	L a d e o disease f l		A p y
3	86	Roy	L	1	Yes	N	C m m d t d l t e d P r f t e d p p e d t A l y f l l	I t n u s	A t p y
4	864	Ched	L	1	Yes	N	L c t h l e c y t u s	T yph d	A t p y
5	869	Mangin	F	1	Yes	Yes		I t r m t e f w h	A t p y
6	87		L	1	Yes	N			S m p t m s
7	8	Sena	L	1	Yes	N		T yph d l l bladd l	S m p t m s
8	87	Sena	L	1	Yes	N		T yph d l l bladd l	S m p t m
9	877	C fi	M	1	Yes	Yes	G ll bladd e d e d t m a l l d e t C y c a n d c o m m t r u e d b y c a l c u l	H a e m o r h i	A o r y
3	89	And d	L	1	Yes	N		C l	S m p t m t f d (feces)
3	880	Semo	F	1	Yes	N		C l	A t (feces)
3	880	Ma.	F	1	Yes	N		G ll bladd l s y m p m d l t s	S m p t m t f d (feces)
33	880	Mass	M	1	Yes	N		C h a c t i c b e p a c l	S m p t m
34	880	Beal	L	1	Yes	N	I m p a t e d m u o d t		A o p y
35	88	W ll	M	1	Yes	N		C l	S m p t m t f d (feces)
36	88	eadm	F	1	Yes	N	L c r a c h o l e c y t u s l e r f f g ll bladd e s T yph d l	T yph d l l	A t y

## GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Co l i d

N		A h	S	Ag	Ch l	Ch l	J d	P t h l g y	Symp ms	If w D known Also Type f Ope
7	88	S dm	F m l	6		Yes		f f f i f g l l b l d i	Typh l P t	A opsy
3	88	M	M l		N	Y	N		A c k i e p t r p m t d e s l l b l d i	S mp ms
	8	M	M l		N	?	Y	Hype ph l	B l r y l f	ymp ms
	8	f	F m l		N	?	Yes	Hyp ph l	Abd m l p	Sym ms
	88	M	M l	3	Y		N	App d l l th ppe dux eco zed as b l a r y		A p y
	88	Ku d	L k	U d	Yes		N		Abd m l l	Symp m (faxes)
	88	J d	M l		Y	Yes	N	T ph d m p e f g l l b l d i E m p m f g l l l l d d	O f yph d l p eum ia	A psy
	88		U k	U d	Y		N	f b l y calcu h f 5 l l d d	fyp l l b l d i l	Ope A p y ?
5	8	R h	F m l	I f	Y			C lcul block g m m d y d ts		A psy
	80	I H m	F m l		Y	Y		S l l b l d i		A psy
		N	F m l		Yes				C l	Ch lec m
		I	U k		Y	Y		Abse f b k f m h h l l w dusch g l Rec ed as b l r y	I d g l m g	ymp ms
	9	h	U k w		N	Yes		B h m m E m p m f l l b l d i ru ed	G d p m yph d	A y
	80	Al i	U k	5	N	Yes		R p f l l b l d i C l es f m l l b l d i h w d b l l yphos	I d d d yph i f	Ope D in f b d m
5	80	I l	M l	mos			Yes	Abd m l dr l d t ed p m b l A m d	V pe	Ope so Dr in A f b d m A ps g d y A pe
			U k	Ch l d	Yes			Hyd d ss scer f		Ope A p y ?
5	9	R cell	M l	8	Yes	Y	Yes	D ded l l b l l l f l l f col l h k m tly d l Hydr A d r d mm	f l f P g l l b l d i l f b dom ppe h	Ch lec os my S l d y s f pe t A p a
	89	h rr	U k	Ch l d	Yes			Hyd f g l l b l d i	Typh d f	Ope A p y ?
55	9	W d l	U k	d y	Y	go loses				A p y
5		M	M l					F b l f f d b d m l J r y d g l l b l d i m p y l	Abd m d d d p gh F l mpe f p l oo R N f m ne bloody ools	Ope d m l dr g
		Ashb	I m l	7	N	Y	Y	L a y l ec d w l l d A f mm l d th k d c j	I d m d d d d m b f f d m d t ded d m b f f Af l pe p d tdev l ped pe d mb l	D l g f ev 2-Ch l d h my A p
58	88	Th mpso	M l	d y	Y	N	Y	C mm rrhos f l	Abd m l p d l uck ool	A p y
5	88	Th mp	U k	I f	Y		Y	l es l l b l d i		A p y
60	88	Th mpso	U k	I f	Yes		Yes	C mm g urrb		A p
6	88	Th mp	U k w	d y s	Y		Y	C mm g hos		A y
6	89	Th m so	U k w	d 7	Y		Yes	C mm g rrh		A p y
	89	Th mpso	U kn	d 7	Yes		Yes	C mm g urrbosis		A p y
64	88	Th mp	U k w	d 7	Y		Yes	C mm g rrh		A psy
65	8	R	F mal	d			Y	Obl te f l f m m d C		A y
60	890	S ill	F mal	m	Y		N	es mm l l b l d i 3 es h p m d d ph tis	F rp p t m w ung ools p t l y-e l d	A y

## GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

N	Age	Sex	Ag	Ch 1 1st a.	Ch 1 2nd a.	Ch 1 3rd a.	Phthlg	Symptom	HWD g Also Type Oper
67	800	Still	F m l	8	Yes	N	T be cul m ang tis M l y	C b l ympt ms	A t p y
68	800	Still	M l	5	Yes	N	L h p m C l l g ll	S b d m n l p m g p l tools palp bl	A t p y
69	800	Still	M l		N	Yes	V sco ty f b l	V m tung b d m l p l ged d p lp bl g ll	Sympt ms
7	90	Still	U k	1 f t	Yes	N			A t p y
7	800	Still	U k	1 f t	Yes				A t p y
7	800	Still	U k	1 f t	Yes				A t p y
73	800	Still	U k	1 f t	Yes				A t p y
74	800	Still	U k	1 f t	Yes				A t p y
75	800	Still	U k w	1 f t	Yes				A t p y
76	800	Still	U k	1 f t	Yes				A t p y
77	800	Still	U k	1 bo	Yes				A t p y
78	800	Still	U k	1 f t					A t p y
79	800	Still	U k	1 f t	Yes				A t p y
8	9	Ogl	F m l	5		Yes	D typh d eek f tta k f f t e d h bl	Abd m l l Typh d	A t p y
8	9	R l l t	M l	6		Yes	E l a ged l d pl B ch p eum G ll bl dd m ll C t d t t ph ed m m d t d l l U h b l ed	An x l m t g f l ools ight d y c l ed	A t p y
8	9	M t h l i	M l		N	Yes	D t d d g ll bl dd W B C ooo C l t e s f m g ll bl dd b ed b l l typh	S b d m l p d m l t d es Rapid y f m scles bl b d m l t m	Ch l e c y t t m y
83	9 5	Ried l	M l	9	N	Yes	B l l l		Ch l e c y t t m y
84	9 5		F m l		Yes		G ll bladd ed p b t	Typ l f f e c t f g ll bl dd T m p f W B C 33 000	Ch l e c y t t m y
85	9 6	Dev H C	M l	3	N	N	R p t f g ll bl dd	I g h m t g m t d m n d i s t d e d I u h h y p o c h d m	Ch l e c y t t m y I l d r g
86	908	hles g	U k	4				Abd m l f	A t p y
87	908	F d j g	U k	4					A t p y
88	908	Ashh t	M l				f f t f g ll bl dd P t t assoc t d t h b l t ed l d	Typh d f l p n p e t t b d m	A t p y
89	908	M l l	F m l	3	N	Yes	C l t e s f p f m g ll bl dd h w e d b l l typhos	S h p b d m l p a t d d t v f g h t e c t m l T m p F	Ch l e c y t o s t m y
9	908	F ed l d	M l	5	Yes	N		C l f f d t d e d g ll bladd palp bl	Ch l e c y t o s t m y
9	909	M y C l i n	F m l	5	Yes	Yes	oed m t C t d t G ll bl dd H y d p	I f d g h t e c t l m g i n f s T d e s h t h y p o c h d r m	Ch l e c y t e c t m y
9	909	Ru d l	F m l	3	Yes	N	G l d l a l l f b p o d d l l i e m t	C l	Ch l c y t t m y
93	909	M t b r u k	M l	5	Yes	N	A c u h y d r p s c m B l p u r t e d G t l y d s d e d g ll bl dd	I t t d e s p l p bl t m	Ch l e c y m y
94	909	C h	F m l	3	Yes	Yes	S m l i g ll bl dd h w f i b o s		Ch l e c y t t m y
95	909	W t	M l	3	N	Yes	E m p y m f g ll bl dd A c u p p e h i s	I t t d e r s s g h t h y p o c h d r m P l p a l g l l b l d f	Ch l e c y t t m y A p p e l e c t m y





## GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

N	Age	Sex	Ag	Ch l	Ch t	Ch t	P th f y	Sympt m	H w D g ed Also Typ Op t
3	9 4	El	N w bo				St t f g l l b l d d		A t p y
3	9 4	Lsh	U k			Y	At t p y—L m l l t b p t t l f u s f k l l b l d d t g	P t t t g b p l t l	A t p y
3	9 4	Aym Om	I f t	Yes					A t p y
33	9 4	Cl k	M l 4 m	Y	Y		C r t l d d f t P t t f b l d m l Hyd p f g l l b l d d	A t t t o c i t	A t p y
34	9 4	D w es	F m l 3	Y to 6	Y t		I -o p t d g os pp	Of t p p d t u s	Ch l e c y t t m y App d t m y
35	9 4	I l s	6 m	Yes					A t p y
36	9 5	B beock			Y		Ch l t t m		Ch l c y t m y
37	9 5	B bc k	4		Y		Ch l y t t m		Ch l e v t t m y
38	9 5	B h	5 1/2		Y				Ch l y os m y
39	9 7	E dr th	F m l 5	Yes to 6	Y	N	G l l b l d d d i s t d d f i l l d t h p l t f l d C y t t d t g r t l y d t d d w t h 4 t	I d g h t h y p o c h d r m d d d t h t h l d A b d m d d d g h t p p q d r t f A m t	Ch l e c y t e c t m y
4	9 7	E dr th	F m l 5	Yes to 6	Yes acute		A c u t p p d A h y d r p s	p g h t p p e q d A m t g M k e d b d m l t l R d u t y h t h a	Ch l e c y t t m y App d t m y
4	9 8	m h es	F m l 3	Y	Yes				Ch l e c y t m y
4	9 8	Smith	M l 5	Yes	Y				Ch l y t t m
143	9 8	Alb			Y		Ch l g t	V t—Alb d b l g d m b e f d h h h d g t d f g t h l e c y d t h t W l l W g h l l e d i n g	S m p t m
44	9 8	K d	F m l 8	N	Y		G l l b l d d d t t l e d t h y o o t m f p C l h h e d p t f b l l t y p h Ch l y t t w h d h e m h g	l d r h e m h d h f b d m h b m h t d f b d m W B C o o	Ch l e c y t t m y
45	9 9	Ch mb	F m l 5	Yes	N		P -o p t d g h l t h	Ch l l y m t g f t b d m l p p f q t t t k f y m p t m	Ch l y t t m y
46	9 9	Lind	F m l 8	Y	Y c u t e		G l l b l d d d t d d W B C	A b d m l m p t h d r m A m t g	Ch l y t e c t m y App e d t m y
47	9 9	D H C	F m l 5	N	Y c u t e		T y p h d g e s t d g l l b l d t w t h f l d f m h h h y b l l w	A c u t b d m l p p t l t t	Ch l c y s t t m y
48	9 9	Call w y	M l 4	Y	Y		T y p h d	4 6 t t k f b l y l y	y m p m
49	9	J b	F m l 4	Yes m a y	Y		O l d p h l y t t h d h k g l l b l d l	A b d m l t d d p i n d p p g h t b l m h l l N m t g	Ch l y t t m y App e l t m y
5	9	J b	M l 3	N	Y	Y	S b t h l y t t N t	l d t t l b d m f m p o o b F W B C 8 o o o	Ch l e c y t t m y
5	9	K n n d y	F m l 3	Yes to 4			App e d t d t e s i n l m	A b d m l p i n g h t h y p o h d m p p d o m t n g y t t	Ch l e c y t t m y App e d e c t m y
5	9	E d t	F m l 5	Yes to 5	Yes		P -o p t d d App d i W l l f g l l b l d d a r l y t h c k	l y r d t y p p m g t d e h t m l e c t M B r n e v	Ch l e c y t m y App e l e c t m y
53	9	B l l	F m l 4	Y	Y		P l d g s A c u t p p e d t d h l c y t t W B C o o o G l l b l d d t e d j f f p r u l t p	f p l w l t m d p p e m l b d m t d h t d r	Ch l e c y t t m y App e l e c t m y
54	9	F d l h	L k 1 f t	Yes	?		m l m m d t G l l b l d d		A o p y

## GALL-BLADDER DISEASE IN YOUNG SUBJECTS—C t d

N		A h		Ag	Ch l	Ch l		P h l e y	Sym p m	H. B. g. o. s. d. Also Type f Op
		H	U kn		N	Y		A p g h l y	F l y p l g l l b l d l	Ch l c y e c m y
		D ry	F m l		Y			C l l b l l f l l f d	Ab l m l p	Ch l c y o s m y
		D	F m l	9	N	Yes	Y	I -ope d Imm l d Appe l l l b l a d l	S b d m l p y m l f y h m m l y ec d m b d m	Ch l c y e c m Appe l m
5		F	M l		N	Y	Y	I -ope d g A l l d	F l p d u g l y b d m	Ope
		F	M l	8	N	Yes	N	Appe l sc l f	F h pa l y p p e	Ope
9		F	M l	8	N	Yes		Absces f l	F y pa m t u n g l co	Ope
		F	M l	7	Y	Y		Auc	F y h l l i m	Ope so
		F	M l		Y	Yes	N	A s d	P l o c y o s	Ope
		K l l	F m l		Y	Yes	N	Ch l m l l m l e d l l l f	F m g r l p l s l p b o d m l l d b o l igh h l h R ec	Ch l c y e c m y Appe dec m y
		P	M l		N	Y	Yes	A l l l d A h d C l l b l d d l f m l 78 m	F l d m l p h l d m l l b o t l Le s c y o s l	Ch l c y o s m y Appe dec m y
5		I l y	M l		Y	Y	Y	A l d l m b l r y E	F l b d m l l i l l m l d l p o o	Ch l y o s o m y Ch l l doch m y
		J l l	F m l		Yes		Y		T l h h y p o c h d p p m	Ch l e c e c m y
67		R l	F m l		Y	Y	N		F l g l l l	Ch l c y o s m y Appe d m y
8		Dr	F m l		Yes	Y	N	l l b l d d m l l h k l l d d c y d g C l l b l d d l d p e f h k l l f m d A	N s e m g N m l l b q l e s N m p l p l	Ch l y o s m y Appe d m y
6		Low be g			Ch l l		Yes	A p f f h l	T y h f l f m l b d m l f d m l m l d u n	Ope
9		B					Y	A p e p p h l e c y	T y p h d f m l d m l	Ope
		B					Yes	A f f p C l h l e c y l p f m g l l b l d f h C b l l y p h	T y p h d f m l f b d m m l l f b	Ope
7		B					Yes	A p f p p d p e h l c y C l h p f l l b l d d p h f b l l	l y p h d f m l y f f b d m p l r b l m l b l f l	Ope
7		P	M l	6	Y	Yes		P -ope d d A p f b l h l p d d f C l p f	F l b d m d h o r t d l l u l h t d nd M B g l b l d l Le oc	Ch l c y o s m y App d m y
		P	F m l	5	Y	Y	Yes	P -ope d d h l y S b h l l h a s C l f b l	F l igh m d g p d h h l l m d b s g l l b l d l p d p p d	Ch l c y o s m y App d m y
75		F sch	F mal	5	N	Y		Oe l m p f l d s f l g d l y m p h	S l f	Ch l c y t m y
		F h	F m l	9	N	Y		S h l b l d d	F	Ch l c y o s m y
		Fisch	F m l	9	Yes					Ope

## GALL-BLADDER DISEASE IN YOUNG SUBJECTS—Continued

No	Age	Sex	Age	Chl	Chl	Chl	Thlgy	Symptoms	Hwdg Al Typ Op
75	9.5	Fsch	Fml	9	Yes		Empty m fg llblld	Tvph df	At py?
76	9.5	Zelg	Fml (1 ed)		Yes		Bl asp ted th gh d od l t b g p lt f b ll y ph P t W d l	Tvph df p bd m p m f bd m l m les ig d y t d espec lly g ll bl dd g	Sympt m
8	9.5	M	M l		Yes		C m fg llblld		At p
8	9.5	Edm	M l	5	Yes		C m fg llblld		Op
8	9.5	M y Cl	Fml	3	Yes				Chlcy t t my
83	9.5	M y Cl	Fml	3	Yes				Chlcy t t my
84	9.5	B k	Fml		Yes	Yes	E m hyl p f b llblld t ng l b tru t f b l r t t E ph j t P l r bl m ight l bo d	A fev du hor m d d d d d d po t k s g d t t y f h F p l s t m p F p y W B C 7 oo poly 6 c	Chlcy t t my P t t d y ft p t A p
85	9.5	M l h	Fem l	5	Yes		P -ope t d gnos A p	F d bo mblcu	Chlcy t t my App d t my
86	9.5	G hw lf	Fml	8	Yes	Yes	A t pp d tus S dy ruda t f d pe t l ty	W k l h t d d f m bd m d d d f m ng du hor y p ec p g	Chlcy t t my App dect my
87	9.5	R be t	Fml	3	Yes	Yes	Hydr p fg llblld th t fl mm G llblld m ed s	Abd m l p no p t y t bd m g f	Chlcy t t my
88	9.5	P tt Wyll	Fml	9	Yes	Yes	G llblld th k d	F bd m l p ht m t bd m A h y	Chlcy t t my App d t my
89	9.5	S yd	M l	4	Yes	Yes	P -ope d gno Acu p p d t C t t fg llblld b l p t C l t h d ptocecu t tyloco cu l b l	Loc l d p M B y b f d m g d d m d g b	Chlcy t t my Appe lect my?
9	9	S yd	M l	5.5	Yes		Org l d g os v t ppe d t C llblld t ged t d p d th k bl g t f m ed f t	Abd m l p m f ght f W B C m o d f bd	Chlcy t t my App dect my
9	9.5	S yd	M l	9.5	Yes		D g Acu pp d tus l t es f bul g m t f t	F p f lb m W B C 6000	Chlcy t t my App d t my
9	9.5	S g			Yes				Op ?
91	9.5	S			Yes				Op t ?
9	9.5	S g			Yes				Op t ?
95	9.5	S g			Yes				Op ?
96	9.5	S g			Yes				Op ?
97	9.6	W k	U kn w	8	Yes	Yes	A dph t t b l d fl mm (haem h g		At py
98	9.6	M l	M l	4	Yes	Yes	G llblld d t d d th lled d g y h tree t m l y ll h fl d w th t	I m gh d f bd m m k es b p d ght m ll g t ght f med l f bd m f m t l h t mbl	Chlcy t t my
99	9.6	Key d Chld	Fml	5	Yes	Yes	I f ed g llblld	Acu bd m	Chlcy t t my App dect my
99	9.6	D J B	Fml	4	Yes			Typ l	Op t
9	9.6	J d l	M l	8	Yes				Chlcy t t my
9	9.6	P tt	Fml	4.5	Yes	Yes	P -ope t du gnos A p p c t t p d t d h l y t t P -chlec t dhes ns Elbow h ped g llblld th k lled d d k col P top t mpl t ac t	Abd m gr ly d d d d d d g d t f gh t t t d es t t bd m m ked ou d mbl f W B C 6000 poly 80 P t t acut y ll	App d t my f ch l c y t dh leaved



bladder were thickened and very dark in color. On account of the child's condition the gall bladder was not drained, no stones could be palpated. Convalescence was retarded and complicated with acetonaemia. Iostoperative diagnosis: acute gangrenous appendicitis, acute cholecystitis. Pathological examination revealed a gangrenous appendix. Iostoperative notes: September 11, 10, 6. Urinalysis revealed acetone and diacetic acid, three plus. This condition persisted until September 2. Temperature 103 to 104 degrees F, pulse from 120 to 140, respiration 44 to 48 up to September 1. Temperature receded from 101 degrees (September 22) to 99 degrees F (September 7) when it became normal. Patient was discharged on the twentieth day, March 19, 1927. Patient was enjoying good health.

# STATISTICAL SUMMARY

Sex	
Males	62
Females	74
Not stated	90
Total	226
Age	
Fetus (6th and 8th month, Cases 2, 1, and 34)	
Newborn	1
Very young (age in days)	9
Infant	19
Child	4
Less than 1 year (1 month to 1 year)	14
Between ages of 1 and 5 years	6
Between age of 5 and 10 years	5
Between ages of 10 and 15 years	65
Total	160
Calculi	
Present	140
Absent	48
Not stated	38
Total	226
Jaundice	
Present	64
Absent	34
Not stated	128
Total	226
Cholecystitis	
With calculi	44
Without calculi	59
With jaundice	30
Not stated	93
Total	226
Calculi in ducts	
Cystic	4
Common	13
Hepatic	0
Not stated	109
Total	126
Hydrops of gall bladder	18
Infection of gall bladder	43
Malignancy of gall bladder (Cases 180, 181, 182)	152
Largest number of calculi found (Case 199)	152
Diagnosis	
By symptoms	21
Operations	16
Autopsy	9
Total	226

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## BRAIN-FLAP—AN INFREQUENT OCCURRENCE IN CLINICAL SURGERY

## ITS EXPERIMENTAL PRODUCTION

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Professo f Cl n l S g ry d D oct f th S g l U R y l o o l f Med in Egypt a U ty

**I**N 1923 Sir William Wheeler (1) described a remarkable condition which he had observed during the course of an intracranial operation

The patient had been admitted to hospital with his forehead bruised and cerebrospinal fluid trickling from his nose. He was breathing heavily and when his skull was opened a marked rise and fall of the frontal lobe occurred with respiration. Another feature of the case was the presence of air beneath the dura—a condition which has been termed pneumocephalus or intracranial aerocele.

With the exception of Wheeler's observation we have found no reference to any mention of a marked respiratory excursion of the brain in the course of an operation, but it has since been the fortune of one of us (A. K. H.) to observe this condition on four occasions.

In the first case the condition appeared toward the end of an operation for hydrocephalus in a child performed by a former colleague, Mr A. A. McConnell at the Richmond Hospital, Dublin.

In the second there was a leak of cerebrospinal fluid from a dilated cerebral ventricle which had been opened during an exploration for abscess of the temporal lobe.

In this case the respiratory excursion of the brain was first seen at the trephine opening on the tenth day after the operation while the case was being dressed and it was then demonstrated to our colleagues, Prof. Biggam and Dr. Barrada.

In the third patient who had lost much blood and was breathing heavily, very large cerebral movements were observed after the removal of an extensive depressed fragment of the frontal bone just in front of the vertex which had deeply indented the dura without actually piercing it. These large movements

were observed for a period of 5 minutes during the closure of the wound.

The fourth patient had suffered an injury so similar to that in the third case that even before the skull was opened we ventured to predict a respiratory movement of the brain. This occurred at once on the raising of the depressed fragment of the bone and synchronized exactly with a deep inspiratory gasp, but after 3 or 4 diminishing excursions the brain ceased to move. In this case the bone fragment had penetrated into the (superior) sagittal sinus.

Dr. Ahmed Handou, a surgical registrar to Kasr el Aini Hospital who operated on the fourth case, has since observed an exactly similar condition in a fifth case, the occurrence of the movement which was large at first, which synchronized with respiration and which proved to be only transient.

In every one of our clinical cases it was clearly seen—in the first, repeatedly—that with expiration the brain bulged outward toward the opening in the skull and that it receded inward from the opening with inspiration.

The unusual movements of the brain are so large that from analogy with the flapping of the mediastinum which occurs with respiration in open pneumothorax we have ventured to coin the name "brain flap."

In the first instance we were led to investigate this phenomenon by experiment because we believed that the occasional presence of air within the cranial cavity after fracture of the skull might be found to be in some way connected with it.

It was soon found, however, that while the apparent explanation of "brain flap" in terms of venous aspiration during the inspiratory suck of the thorax might at first sight



seem obvious and complete the condition in fact afforded a problem of some complexity. For this reason we have at present confined our experiments to its elucidation leaving the original question of intracranial serocele for further study.

#### LITERATURE

With the exception of the paper by Wheeler already referred to we have been unable to find any reference to the phenomenon of brain flap in any surgical publication. It would seem that Wheeler himself was also unaware of the existence of any such publication.

The textbooks both of surgery and physiology available at the time were also silent on the point. Again such journals as were accessible gave no hint as to whether any work had been done on this subject or not. In consequence we decided to perform the experimental work and hoped that during the summer vacation one of us would be able on his return to England to make a further search into the literature. This was fortunately the case and through the kindness of Sir Charles Sherrington we are able to cite some earlier work of which previously we had been in ignorance.

Mosso (1) was able to examine the movements of the brain in cases in man in which through injury or disease the covering of the brain had been destroyed. He observed pulsation due to both the circulation and the respiration. To us it is somewhat surprising that his recorded change in volume due to respiration are so small in comparison with those due to the circulation. In our work as will appear later the latter were only occasionally observed while the former might be and often were very extensive. Mosso attributed the changes in volume to variations in the blood content of the skull following on the respiratory movements. Naturally he was unable to determine the effects produced by such procedure as section of the vagi.

A paper by Roy and Sherrington deals with variation in cerebral volume (8). The work there described was undertaken with the desire to determine the presence or absence of a vasomotor supply to the cerebral vessels. There were certain differences in technique between their experiments and ours and if

we remember the differences between their objects and ours it is not surprising that they only incidentally mention the effects of respiration on the cerebral volume. As far as the procedure in the two sets of experiments is similar the results show a close resemblance a fact which gives us the greater satisfaction in that our work was done in complete ignorance of the earlier publication.

The two publications are the only papers in which we have been able to find accounts of work done under conditions similar to our own in that the cranium has been opened and its contents exposed to atmospheric pressure during the whole of the experiment. Hill (3) has published the results of experiments on the actual cerebral volume but with the trephine opening blocked. All other work such as that of Knoll (4), Becht (1), Weed (10) and very many others deals solely with intracranial pressure and almost always under the conditions of a closed cranium.

#### EXPERIMENTAL METHODS

To the purposes of this research dogs of from 4 to 15 kilogram in weight have been used. In the animal experiment the given by the open method was used as the standard but it was soon found possible to adapt the method of intracranial insufflation for the measuring of intracranial pressure.

**Blow-pump.** The ventricles of the brain were exposed by means of a mercury manometer connected to the annulus of the femoral artery usually on the right side. A cannula was inserted into the femoral artery and the other end permitted such that no air was injected and required to be made. **Respiration.** Various methods of recording the respiration were used such as Gunn's stethograph (5). For respiration which will become apparent in the latter part of the paper the method which in the recording of movements of the thorax or abdomen (1) is a delicate method of which enables variations in the intrathoracic negative pressure to be recorded. For this purpose two glass tubes one long and one short were fitted by means of rubber cocks to a 20-necked 11-litre bottle of a capacity of 1 liter and about three-fourths filled with water. To the long tube which opened well below the surface of the water in the bottle a short thin-walled metal tube connected by means of rubber tubing. The other extremity of the metal tube was fashioned into a bulbous end. The short glass tube was similarly connected to a delicate tambour. A small incision was made through the skin and deep fascia over an intercostal space and the beveled end of the metal tube inserted. By means of a purse-string suture the

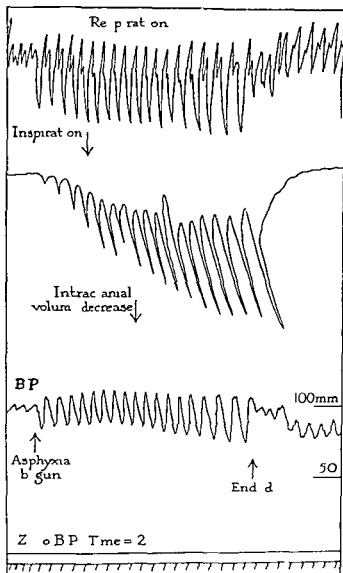


Fig. 1. The uppermost line represents the change in negative pressure in the thorax, lowering of pressure is inspiration causing the lever to move downward. The middle section records changes in intracranial volume reduction causing the lever to descend. The next part corresponds to the systemic blood pressure. Below this are two lines, the upper giving the level of zero blood pressure and the lower intervals of time correspond to 2 seconds. The figures at the right hand side correspond to the height at which the blood pressure recorder would stand for definite levels of pressure. Asphyxia is used as a convenient abbreviation for occlusion of the tracheal cannula. These observations apply to all further tracings and no further repetition of these remarks will be required. So far as possible, the initials and all other tracings the various lines have been so arranged that vertical lines drawn from top to bottom would show synchronous changes in each line.

On commencement of asphyxia there are immediately large changes in intrathoracic pressure. Similarly the intracranial volume lever previously steady, shows rapid movement, growing more pronounced and at the same time there is an increasing lowering of the point to which it then turns increasing to a maximum. The blood pressure remains generally steady although the respiratory waves are greatly enlarged. At the end of asphyxia

skin was drawn closely around the tube to form an airtight joint. The tube was then thrust through the intercostal muscles so producing a connection between the pleural cavity and the Woulfe's bottle. Any variation in the pressure within this cavity will cause the water in the long tube to rise or fall which in turn will abstract from or add to the water in the Woulfe's bottle and so vary the pressure in the air space above the water. The tambour will be affected by the variation in pressure and the lever will fall with a decrease and rise with an increase of intrathoracic pressure. Given a sufficiently large tambour it would be possible to connect the intrapleural cavity direct to the tambour but the changes of pressure are so great that the size of tambour required would be quite impracticable. The Woulfe's bottle is inserted into the system to reduce the pressure variation to be recorded and the size of the tambour required. The larger the amount of water in the bottle the larger will be the movements of the tambour lever for any given change of intrapleural pressure and vice versa.

**Brain flap.** To obtain records of the variations of intracranial volume which form the subject of this paper the temporal muscle on one side usually the left was reflected and a hole cut in the parietal eminence by means of a trephine, 1 centimeters in diameter. Care was taken to avoid damaging the dura mater and twice only in the whole series of experiments did such injury occur. Sometimes there was severe hemorrhage from the diploe which was controlled by means of a piece of muscle and pressure. When bleeding had ceased an instrument made specially for this purpose was inserted into the opening. This was made for us by Mr. Price, late of the Physical Department of the Egyptian Ministry of the Interior to whom we desire to express our gratitude. A piece of brass 3.5 centimeters in diameter was turned down at one end to a diameter of 7 millimeters. The other end was fashioned into a cone of the exact dimensions of the hole left by the conical trephine. A flange of the full diameter of the brass was left at a distance of 1 millimeters from this end. The conical portion was bored out to an internal diameter of 16 millimeters and on the outer conical surface a fine but deep screw thread was turned. A hole 5 millimeters in diameter was then drilled from the narrow end to join that from the wide end. This instrument was screwed into the opening in the skull and to insure an airtight joint a strip of vaselined gauze was wound between the skull and the flange round the junction of brass and bone. Connection was then made by means of rubber tubing to a volume recorder made by Messrs. Palmer of such delicacy that a change of intracranial volume of one tenth of a cubic centimeter caused a movement of the writing point on the surface of the drum of 1 centimeters of arc.

There is an almost complete cessation of the movements of the volume lever and the on the left is rapidly re-attained. The respiratory movements remain large on account of the previous deprivation of oxygen.



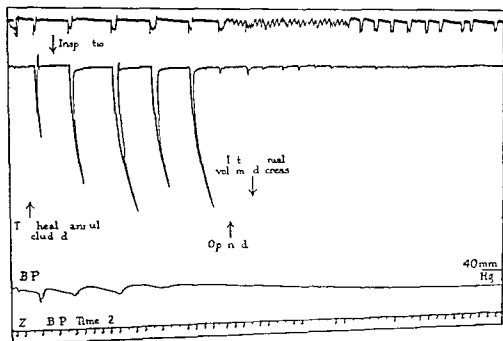


FIG. 4. A tracing from a moribund dog in which respiration took the form of gasp. The immediate appearance and disappearance of brain flap on occlusion and release of the tracheal cannula are characteristic. The synchronicity of the movements of the volume and respiration levels is well marked.

ment of changes in diameter or volume of the chest or abdomen.

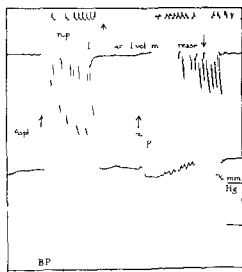
*Division and stimulation of the vagus.* Another method of demonstrating the close association between brain flap and respiration was sought. If one vagus nerve be divided in the neck, the other being left intact, stimulation of the central end of the cut nerve will cause cessation of respiration with little or no accompanying change in the systemic blood pressure. Brain flap was induced in an animal and when the movements of the intracranial volume lever were pronounced, stimulation with the faradic current of the central end of the cut vagus was commenced. At once the movements of the lever recording volume and respiration ceased. Immediately the stimulus was stopped they recommenced. This is displayed in the tracing reproduced as Figure 2. If both vagi are divided, stimulation of the central end of one causes a considerable rise of the systemic blood pressure due to stimulation of the vasomotor center alone, without the concurrent depressor reflex which will be present if one nerve is left intact. In consequence the results obtained under these conditions are of less value, as will be more readily appreciated when the experiments described in the next section of the paper are considered (Fig. 3).

*Gasping.* Figure 4 is a reproduction of a tracing obtained from a moribund dog. In this animal respiration consisted only of a series of gasps. While the air entry was impeded, the movements of the levers recording variations in intracranial volume and respiration respectively will be seen to be exactly synchronous, both moving downward with inspiration and upward with expiration. When the obstruc-

tion to respiration was removed, there was a short period of more rapid respiration soon followed by a recurrence of gasping. It will be observed that though the movements of brain flap are well marked while the tracheal cannula is blocked, they cease at once on the removal of the obstruction to air entry and do not recur with the reappearance of gasping.

*Association of brain flap and respiratory movements with inflated or deflated chest.* Another type of experiment was performed to demonstrate the dependence of brain flap on a further decrease of the normally negative intrathoracic pressure. Figure 5 is a reproduction of a tracing which may be divided into two parts. In the first, the tracheal cannula was occluded when the chest was at its smallest volume at the commencement of inspiration. When the cannula was closed, the pressure changes in the pleural cavity were immediately greatly increased, the negative pressure becoming more negative with inspiration. Brain flap appeared at once the movements of the lever being practically at their maximum from the beginning. In the second part, however, the air entry to the lungs was cut off with the chest distended at the end of inspiration. Under these conditions, a period of time elapsed before the changes in intrapleural pressure with respiration became much increased. At the same time, as can be seen from the tracing, brain flap began at once but the movements were very much less marked, being very small at first and gradually increasing to about half the size of those obtained in the earlier part of the tracing.

*Stimulation of the phrenic nerves.* It was thought that information might be gained from the results of artificially induced movements of the diaphragm



I c I d m t at th l t l p b t l  
 d p d th d f p f th t l I th t t  
 p t ph w mm d t th J f p t  
 Th m m nt f t th th p t d l m l  
 l m m l t l t t l th d p a t  
 f h b t th d f p t Th m  
 m t f b th l m l l b h w th l l y  
 g l t t t t w th f t th  
 h t p t f h p r a t t r w m d th t th o  
 g p l th p m nt th l m d f d th  
 p t

The ph n c n v w a o l a t d n th n k n both  
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 s branch of the b a h a l n o t f t h a l p l e x s  
 B c a u f t h i t a u a u a l m p b l t o l t  
 m o t h n a p r t p e h a p t o t h l of the n e r v e  
 t h u t the r i s k f n j u r t h t h p l e u r a o g r e a t v i n s  
 Th n r w e t h t m u l t e d s m u l t n c o s l y  
 g t h t h e l t o d p l l s r i s a s t n u r  
 the n g o f t h m a m o n t f c u n t b y b o t h  
 n e r v e s Th r t y p o f t m l t n e m p l o y l  
 s n g l e s h c k s h t l l g f a r a l z a t i o n The  
 t r a h a l n u l a o c l u d f b f b t o n l y j u t  
 b f r e t h m m m e n t o f t h t m u l a t n

Figure 6 shows the result of a long faradization. The w s a n m m e d i t e and p o f o u d l m n t i o n  
 o f n t a c a n i a l o l u m c o m p r i n l b y a c n s t i c  
 a b l e r e d u c t i o n o f i n t p l e u r p r u r A s i t a s  
 i m p o s s i b l e t o s o l a t a n d s t m u l a t e t h o l e r v e  
 t v a s i m p o s s i b l e t o o b t a i n a t e t a c c o n t r a c t i o n o f  
 t h o l d p h r a g m I n s e q u e n c e s m a l l m o  
 m e n t s o f b o t h l f o l l o t h e f s t b i g m o m e n t  
 I t w i l l b e s e e n i n t h e t r a n g t h t h i n t r a c a n i a l  
 v o l u m e l t h o g h n o t r m i n g a t t s m m u m  
 p o i n t d e s n o t r e t u n t t s o g n a l z e u n t l t h e  
 s t m u l a t n h a e d Th s i p r o b a b l y b e a t  
 t r b u t t o t h t m u l t i o n c a u s i n g t h e d a p h r a g m  
 t r e m a n p a r t i a l l y c o n t r a c t i o n D u g t h e p e o d  
 o f s t i m u l t o n t h e a r t l b l o o d p e s u r o s e b u t  
 t h e r w e c o n s p i r a t r y v e s s u p e r e d o n t h e  
 t r a c i n g N o r e s u l t s e c o b t a i n e d f r o m s t m u l a t o n

f the n r v e s w i t h s i n g l e s h o c k s b u t s h o r t p e r i o d s  
 o f f a r a d i z a t i o n w i l d t r a c i n g s s i m i l a r t o t h e o n e  
 a l r a d y d e s c r i b e d

**Tracings** Figure 7 taken from a tracing recorded on a rapidly moving drum and permits a closer analysis of the time relation between the movements of the levers recording changes in the intracranial volume and in intrathoracic pressure respectively. Careful measurement shows that the two levers reach the lowest points simultaneously. On the other hand the commencement of these movements is not synchronous; the intrathoracic pressure being considerably lower before any change in the intracranial volume could be detected. The expiratory phases however ran closely parallel to one another with some tendency for the restoration to the normal of the intracranial volume to precede that of intrathoracic pressure. Other tracings have been similarly analyzed. The only appreciable difference between the findings in the and the finding already reported is that the former may be a lag in the production of the maximum decrease of intracranial volume as compared with that of intrathoracic pressure. This is more noticeable in those cases in which the movement obtained were very large in magnitude and probably instrumental in origin due to the inertia of the moving lever.

#### Effect of Intracranial Pressure

At first it is generally found that at the beginning of an experiment on the most vigorous inspiration movements couple the condensible resistance to air entry produced only by small movements of the lever corresponding to changes in intracranial volume are none at all. Occasionally there might be a few movements of the lever each smaller than its predecessor and the whole thing was rapidly although the resistance to breathing was still maintained (Fig. 8).

On the other hand after the experiment had been in progress for some time it was usually possible to induce quite large movements of the intracranial lever using method apparently exactly the same as that which had previously failed. In the first case the animal was in good addition the normal blood pressure. In the second the results of the operation interference had impaired its condition with usually but by no means as low a level of blood pressure. It is thought therefore that one of the essential factors is also the condition of the blood pressure.

**Lag in the Trachea** The most obvious way of stimulating the hyperventilation to stimulate the peripheral end of a cut vagus nerve during a period of vigorous inspiration with the tracheal cannula blocked. Experiments were performed on these lines and a tracing from one reproduced as Figure 9. From this it will be seen that closure of the tracheal cannula produced small movements of the brain flag exactly similar to those shown in Figure 8. When these had ceased the peripheral end of the cut vagus nerve was stimulated, the final current. The blood pressure fell at once to about half its previous height.

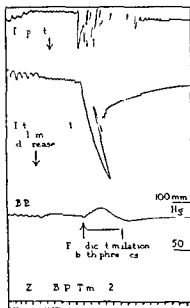


FIG. 6

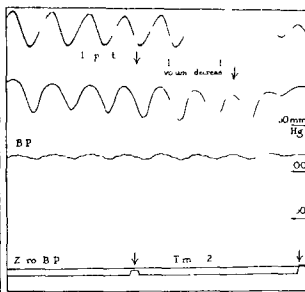


FIG. 7

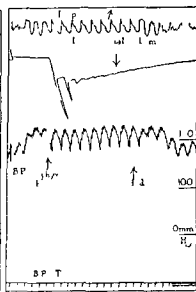


FIG. 8

FIG. 6 To show the result of simultaneous faradization of both phrenic nerves. A rapid diminution of intracranial volume occurs simultaneously with a similar diminution of intrathoracic pressure caused by the sharp descent of the diaphragm.

FIG. 7 This tracing was taken on a rapidly moving drum to permit analysis of the time relationships between the movements of the respiratory and volume level

and as promptly recovered on the cessation of the stimulation. No sign of brain flap was observed either during or after the period of stimulation. The

FIG. 8 This shows the type of brain flap which occurs occasionally at the commencement of an experiment. Coincident with the commencement of apnoea there is a sharp fall of the volume lever but with each successive respiratory movement the extent of the excursion of the volume lever is less the while dying away rapidly. This occurs in spite of the continuance of the resistance to breathing.

whole experiment was then repeated with similar results.

*The effect of histamine.* Another possibility was that brain flap does not occur without the coexistence of some degree of shock. Undoubtedly the combination of anaesthetic operative interference exposure etc. would be likely to cause this condition which was probably always present to a greater or less extent after an hour had elapsed from the commencement of the experiment at about which time brain flap commonly made its appearance.

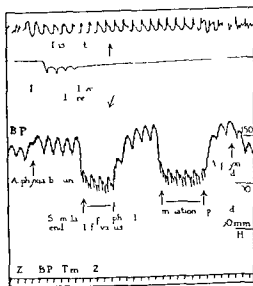


FIG. 9 This tracing shows to commence with a few movements of the volume lever exactly similar to but smaller than those in the preceding figure. When these had ceased the peripheral end of the cut left vagus was faradized. The blood pressure fell considerably but although the tracheal cannula was blocked there were no signs of brain flap. A repetition of the experiment was also without result. In this tracing the respiratory lever moves upward in inspiration.

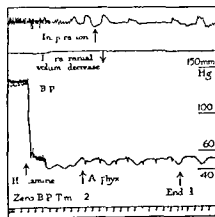
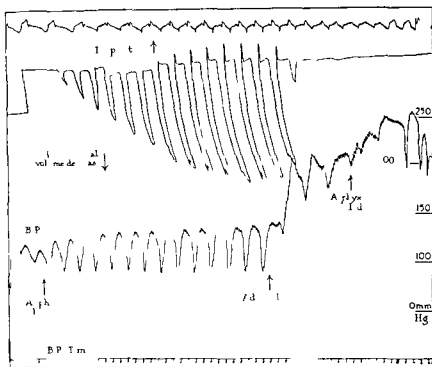


FIG. 10 To show the result of the injection of histamine. The usual profound fall of blood pressure occurred but in spite of vigorous inspiratory movements no trace of brain flap could be seen. The respiratory tracing was taken with a stethograph the lever moving upward in inspiration.



Γ B fl p l g b d d by phyx bo t m l g m f  
d l w j t d t ly Tl p c t d f l l o o d p s c l  
h t t t h g p h f b fl p l p t w a c d d

Again the cause clearly nil bed  
all shock must have been present in a  
very marked degree.

To make surgical shock mild doses of h  
n phosphate (about milligrams) were injected  
intravenously during the experiment when attempts  
to produce brain flap by occlusion of the tracheal  
cannula had already been found to fail. A tracing

produced in Figure 10 displays characteristic  
prompt and severe fall of systemic blood pressure

which follows the intracranial administration of the  
drug. At the same time occlusion of the tracheal  
cannula produced not the faintest sign of brain flap.

Adrenalin: The most certain method of inducing  
this condition is found to be the administration of  
intravenously administered adrenalin (about 1  
milligram). The usual immediate and pronounced  
fall in the systemic blood pressure followed by a

might rise to 50 or 60 milligrams of mercury.  
Within the immediate effects of the drug had produced  
if the blood pressure fell to a level below that at

which it had been before the injection. It was then  
found that in an animal in which there had previously  
been no movements of the intracranial volume

level following occlusion of the tracheal cannula  
brain flap was readily produced by this method and  
that the excursions might be very large.

Figure 11 is a tracing produced to display these  
points. Afterward the animal remained sensitive

to this treatment for some time usually until the  
end of the experiment. Occasionally two injections  
of adrenalin were found necessary.

Adrenalin sensitization: Further observa-  
tions concerning this method on an animal thus rendered  
sensitive to occlusion of the tracheal cannula. Brain

flap as induced in the usual manner and a further  
subject in fallowing in. It was then found that

paradoxically the rise of the systemic arterial pres-  
sure in the intracranial volume ceased  
though there might be an increase in the arterial

volume. While the blood pressure was  
rising or falling the pressure in the brain remained  
practically constant near the maximum. It is difficult

to demonstrate in the brain flap by occlusion  
of the tracheal cannula. However, if the in-  
tracranial movements might be. When however

the blood pressure had commenced to fall because  
of the falling of the adrenalin action the move-  
ments of brain flap could be induced easily, but at a much

higher level of blood pressure than that at which the  
movements ceased while the pressure was rising (Fig.  
12). It was also observed that if the rise of blood

pressure was slow as a result of the very gradual  
injection of adrenalin the diminution in size of the  
movements of the intracranial volume level was

also gradual varying more or less in degree as the  
rise of the blood pressure as shown by the tracings  
in Figure 13.

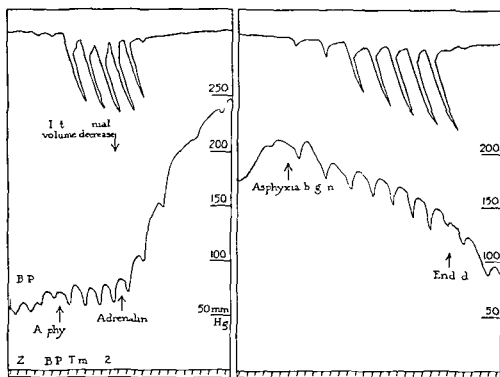


Fig. 12 The first part of this tracing shows the abolition of brain flap by the intravenous injection of adrenalin just as in the last figure. In the second part however it will be evident that at a time when the systolic blood pressure was still at a height above that at which brain flap had previously ceased though below its maximum asphyxia was able to re-induce the condition. For exact synchrony between the volume and blood pressure tracings the latter should be transferred one sixteenth of an inch to the left.

#### *Influence of Interference with the Cerebral Circulation*

At first attempts were made to examine the results of occlusion of on the one hand the carotid arteries and on the other the external jugular veins the internal in the dog being remarkably small or even absent. No definite results were obtained from this procedure alone. It was thought that this was probably due to the very efficient blood supply afforded by the vertebral vessels. In consequence the method of ligating these vessels was employed which was introduced by Sherrington (9) for the decapitation operation in cats. In this a piece of stout string is passed by means of a packing needle in front of the vertebral column and the ends brought out on the dorsal surface of the neck. The muscles of the back and sides of the neck are then divided and the string tightly knotted at the back so that the vertebral vessels are compressed against the spinal column.

**Occlusion of the carotid arteries.** After both arteries had been freed from the other structures contained in the sheath a ligature was passed loosely round each in such a manner that when the ends were pulled the lumen of the vessel would be obliterated without at the same time any risk of damaging its coats. On release of the ligature the blood supply to the brain was instantly restored. The natural result

of occluding these arteries after the vertebral vessels have been tied is to stimulate the vasomotor center by the resulting anæmia of the medulla and so to cause a rise of blood pressure. This in fact did not always occur probably because of the extensive anastomoses described by Hill (3) between the intercostal and spinal arteries.

After the experimental animal had been rendered sensitive to occlusion of the tracheal cannula the air entry was checked and as soon as brain flap was established the carotid arteries were occluded usually simultaneously. The result in most cases was a fall in intracranial volume coupled sometimes with an increase in the size of the excursions of the lever. On releasing the ligatures there was a rapid increase in the intracranial volume together with a reduction or abolition of brain flap (Fig. 14).

Sometimes but not in this case the volume lever ultimately reached a level higher than that at the beginning of the experiment showing that the intracranial volume had undergone some more or less permanent increase.

It will be noticed that the arterial blood pressure rose to nearly 200 milligrams of mercury while the movements of brain flap were still very large. This does not in any way antagonize the statements made that the action of adrenalin in causing a rise of blood pressure prevents or stops the development





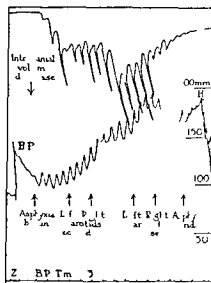


Fig. 14. To show the effects of occluding the carotid arteries the vertebral being already ligated. When apnea was started there was a small reduction in intracranial volume. When this had reached a steady level the two carotids were occluded. No change fell well with the locking of the first but on closure of the second there was a further diminution of intracranial volume with an increase in size of the brain flap excursions. On release of one artery the intracranial volume began to increase and on release of the second this became more rapid and was associated with an almost complete cessation of brain flap. The rise of systemic pressure is due to anemia of the autonomic center in the medulla. The blood pressure acting should be transferred one or both of an inch to the left to obtain synchronicity with the volume record.

Adrenalin as has already been stated causes the movements of brain flap to cease. Not only does it do this but usually causes in addition the intracranial volume to increase.

Although no change of intracranial volume is shown in Figure 10 following the injection of histamine a diminution usually occurred and might be large. On one occasion it was very well marked the volume and blood pressure recorders falling almost parallel to one another.

On a few occasions over vigorous artificial respiration by the pump has caused in a sensitive animal the inverse of brain flap. In this there has been an increase in the intracranial volume with each positive (inspiratory) stroke of the pump. When the pump was disconnected from the tracheal cannula there was a prompt cessation of these movements and a reduction in intracranial volume. Further when the tracheal cannula was blocked true brain flap was produced the intracranial volume falling with each inspiratory movement.

Figure 16 has been prepared to show the results of forcible compression of the heart in the dead animal. Immediately after death the chest was opened and the heart squeezed vigorously with the hand. Each compression was followed at once by a rise in the intracranial volume succeeded by a return of the lever to the base line on relaxing the grip.

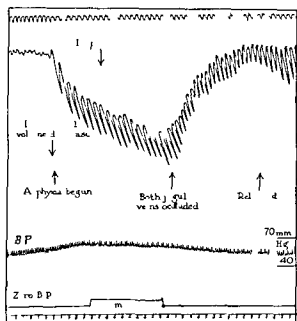


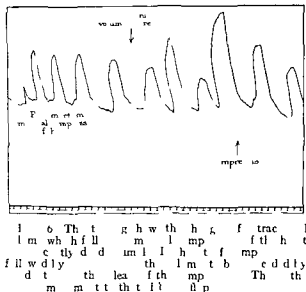
Fig. 15. To show the effect of occlusion of the jugular veins the vertebral being already ligated. When apnea was started there was a small reduction in intracranial volume. When this had reached a steady level the two jugulars were occluded. On release of the first the volume began to rise but on closure of the second there was a further diminution of intracranial volume with an increase in size of the brain flap excursions. On release of one artery the intracranial volume began to increase and on release of the second this became more rapid and was associated with an almost complete cessation of brain flap. The rise of systemic pressure is due to anemia of the autonomic center in the medulla. The blood pressure acting should be transferred one or both of an inch to the left to obtain synchronicity with the volume record.

A somewhat similar result was given by blowing strongly into the pleural cavity of an animal immediately after death through the tube inserted for the purpose of registering the changes of pressure within that cavity.

#### DISCUSSION

At the outset it must be emphasized that the clinical observations and experimental results here reported do not and are not intended to represent a state of affairs occurring in the normal condition. The mere fact that the skull has been opened and the dura exposed to atmospheric pressure during the whole course of the observations is at once fatal to any such suggestion. It is in our opinion in the highest degree improbable that any such variations in the cerebral volume as are here described can occur in the animal with an intact skull.

It was suggested by Monroe (6) about 150 years ago that the bony skull could be regarded physiologically as a rigid box and this view has met with general approval. I accept in so far as there may be a possibility of forcing cerebrospinal fluid for a very short



distance along the nerve sheaths as they are used from the skull it would seem that there can be no change in volume of the total intracranial content and that such changes as are here described could never occur so long as the bony cranium remains intact.

Under the conditions of experiment as here described it is clear that the dura mater may on the one hand fall into a considerable extent and on the other bulge outward slightly until the limit of elasticity of the membrane is reached. It is with such changes in volume occurring very rapidly that we are concerned.

In the first place we have to consider which substance of those present within the skull can undergo such rapid changes. It is inconceivable that the solid matter, the gray and white matter of the brain, can change in volume with such rapidity. There is little room for doubt that the cerebrospinal fluid secreted by the choroid plexuses and absorbed into the veins through the pachionian bodies may vary in volume from time to time. It is however in the highest degree improbable that these processes of absorption and secretion should take place with the rapidity of the movements of brain flap and that they should have when present that time relationship with the respiration which is also characteristic of brain flap.

There remains the content of blood within the skull. This quantum whatever it may

actually be from its nature as part of the blood in general circulation is eminently variable. The tracing shown as Figure 16 shows clearly that changes of intracranial volume may be due to variations in the blood content. On compression of the heart immediately after death the volume lever attached to the skull rose and on relaxation of the compression it fell to its original level. Here there can be little doubt that compression of the heart had forced blood back through the practically valveless great veins (3) of the neck into the cranial cavity. There was no complication due to respiration, artificial or natural, to confuse the issue. Although it is true that the movement shown in the tracing is the exact inverse of that seen in brain flap, this is of no importance. The tracing shows that variations of blood volume in the cerebral circulation can produce marked change in intracranial volume.

We may conclude then that brain flap is dependent on variations of the content of blood within the skull. We have now to consider what factors are or may be concerned in the production of these variations. The volume of blood within the skull from moment to moment must depend on the relative rates of inflow and outflow. There are three possible conditions, that in which the inflow equals, is greater than or is less than the outflow.

In the first case the quantity of blood in the skull will remain constant and there will be no brain flap. This is the usual condition unless special measures are taken to upset the balance between inflow and outflow.

In the second condition with inflow greater than outflow there will be a tendency for the intracranial tension to rise and this will be displayed under these experimental conditions by a bulging of the dura mater through the trephine opening with a rise in the volume lever. This was found to take place in an experiment in which all exit of flow from the skull was prevented while the carotid arteries remained open. This was done by temporary occlusion of the jugular veins, the vertebral vessels having been previously tied (Fig. 15). No brain flap will arise from this procedure alone.

In the third case with inflow less than outflow there will be a tendency for the intracranial pressure to fall and under our experimental conditions this will appear as a sinking in of the dura mater and a fall in the volume lever. This was found to be the case when the carotid arteries were temporarily blocked after the vertebral vessels had been tied (Fig. 14). This *by itself* will not give rise to brain flap.

The condition of brain flap is characterized by a rapid alternation of the conditions present in the second and third cases, a rapid fall and rise of the volume lever, the excursions of the lever in each direction being equal or nearly so with a tendency for the upward movement to be less than the downward. This may be stated as a rapid alternation of short periods of time in which inflow is less and greater than outflow.

We will next consider the conditions governing the flow of blood into and out of the cranial cavity. On the side of inflow there is the systemic blood pressure opposed by the resistance of the arterioles and capillary bed. To cause outflow there is the venous pressure, practically the resultant of the two former forces, aided or opposed by the changes in intrathoracic pressure during inspiration and expiration. At the same time it should be remembered that the whole intracranial circulation is subject to the almost constant pressure of the cerebrospinal fluid, a pressure of the same order as and varying slightly in either direction from that in the veins (1).

If the experimental observations are considered it will be clear that they may be divided into two groups, those in which brain flap did and did not appear respectively. It may be observed here that in most respects there was no difference in the experimental procedure employed in both cases. The former group will be considered first.

In all the experiments in which brain flap was produced there was only one constant factor, excessive aspiration by the thorax. Hyperpnoea alone, even when very vigorous, was not sufficient to induce the condition (Fig. 1). Hyperpnoea if the air entry to the lungs be perfectly free as it is with a large bored tracheal cannula will produce but

little change in the intrathoracic pressure and so little change in the aspirating action of the chest in inspiration on the blood contained in the thin walled great veins. On the other hand if the lungs cannot follow freely the movement of the chest wall in inspiration the pressure in the pleural cavity will be greatly reduced and the aspirating effect correspondingly increased. If then the tracheal cannula be blocked at the end of expiration the result of even normal breathing will be to cause considerable diminution of the intrapleural pressure on inspiration with a return to the previous pressure on expiration. This will produce a great increase in the aspirating effect during inspiration and a rapid decrease during expiration. This should and under the right conditions does induce that type of brain flap in which the movements are large from the beginning (Fig. 5, the first part). Again it would be expected that if the tracheal cannula be blocked at the end of inspiration there would be less tendency for the intrapleural pressure to be further reduced with succeeding inspirations until on the one hand accumulation of carbon dioxide in the blood caused the respirations to become deeper and on the other the continued abstraction of oxygen by the blood from the lungs had reduced their volume and the intrapleural pressure. Under the right conditions brain flap in which the movements should be small at first and gradually increase in size would thus be produced (see Fig. 5).

Stimulation of the phrenic nerves on both sides simultaneously leads to a sharp descent of the diaphragm and with the tracheal cannula blocked to a sudden diminution of intrathoracic pressure. Experiment showed again that this diminution with its inspiratory effect produced an equally rapid reduction of brain volume (Fig. 6).

Even more conclusive proof of the dependence of brain flap on respiration was obtained by those experiments in which the central end of one vagus was stimulated the other nerve being left intact (Fig. 7). While brain flap was being maintained as a result of occluding the tracheal cannula stimulation of the nerve was commenced. This caused respiration to cease during the period of stimulation. Brain

flap ceased with the cessation of respiration and recommenced with the respiration on the termination of the period of nerve stimulation. Here there was only one difference between the periods with and without brain flap: the fact that the respiration and with it the aspirating effect of the thoracic movements had ceased. The blood pressure remained practically constant throughout.

Consideration of the time relations between the movements of the intracranial volume and of the intrathoracic pressure (Fig. 4 and 7) shows that both reach their lowest points simultaneously. This means that the maximum diminution of intracranial volume occurs at the same moment as the maximum reduction of intrapleural pressure or the maximum aspirating effect. This confirms the dependence of brain flap on the action of the thorax. At the same time it supports the suggestion which might be made that the changes in intracranial volume are the result of exaggerations of the normal respiratory wave found in the arterial blood pressure tracing. It is true that the c wave is exaggerated by the occlusion of the tracheal cannula as would indeed be expected, and this may be seen to be the case in Figures 9 and 11. It is however well known that the arterial pressure rises during the last two thirds of the inspiratory phase to reach its maximum at the end of the first third of expiration. Now with a rise in arterial pressure the intracranial volume rises and were brain flap due to an exaggeration of the respiratory waves on the blood pressure there should be an increase in intracranial volume reaching its maximum at a point in close proximity to that at which in fact it is at a minimum.

We have now considered fully the relationship between brain flap and one of the factors concerned in the regulation of the outflow from the cerebral circulation: the aspirating action of the thorax. Little has been said with regard to the damming back of blood which occurs with expiration except in so far as it is responsible for the return of the volume of the cranial content to its previous position. It must be remembered that the dura mater is a very tough inelastic membrane which will offer considerably higher resistance to a

force tending to cause it to expand than will be the case with the thin walled veins. The other factor in connection with the outflow from the brain is the venous pressure. This is so dependent on the arterial blood pressure that it need no special treatment.

The effects of variation in the resistance to the flow of blood offered by the cerebral arterioles and capillary bed need hardly be considered. It is well known that the arterioles are very badly supplied with smooth muscle fibers. Agun Loy and Sherrington (8) have shown that the vessels in experimental animals are devoid of a vasomotor nerve supply. In consequence they will respond only very slightly if at all to the usual agent causing constriction or relaxation of the elements. Roy and Sherrington found that the circulation in the brain was directly determined by the systemic blood pressure.

The relationship between the systemic blood pressure: the more important factor concerned with inflow of blood to the cerebral circulation and brain flap must now be considered. This condition has been induced with arterial pressure as measured in the femoral artery ranging from 140 to 40 milligrams of mercury indicating that there is little connection between the actual height of arterial pressure and occurrence of brain flap.

On the other hand it was found that the great rise of blood pressure caused by the intravenous administration of adrenalin would put a stop to brain flap induced by occlusion of the tracheal cannula although the interference with respiration was still maintained. This suggests that a very high blood pressure is incompatible with brain flap.

Further experiments however showed that when the blood pressure had fallen somewhat from its highest point but was still above that at which brain flap had previously ceased the condition could again be induced by occlusion of the tracheal cannula. From this it would seem that the mere height of blood pressure is not alone the cause of the cessation of the movement.

In order to arrive at an explanation of these apparently contradictory findings it will be necessary to consider what changes will occur in the cerebral circulation as a result of the

administration of adrenalin. It has been shown that in the animal with the skull intact the effect of adrenalin is to raise the arterial, venous and cerebrospinal fluid pressures (1). Our own experiments show that besides the cessation of brain flap there is an increase of the volume of the intracranial contents. This must mean that blood is being forced into the skull at a rate greater than that at which it can escape. If blood is already leaving the skull at the maximum possible rate, as must be the case under these circumstances, aspiration by the thorax cannot increase this rate and in consequence brain flap should cease as in fact it does.

It has been shown by Becht (1) that after the administration of adrenalin the venous pressure rises in the cerebral sinuses with the systemic arterial pressure and is maintained at a relatively high level for some time after ward when the latter has fallen considerably. Although the venous pressure remains high the fact that the arterial pressure has fallen points to a diminished inflow of blood. If this is the case it is evident that aspiration will be able to withdraw blood at a more rapid rate than that of the previous outflow while expiration will check the process. As a result of these two factors brain flap will occur. Further the extent of the movements should increase with a further fall of arterial pressure (see Fig. 1).

Additional support is lent to this argument by the facts recorded in Figure 13. Here adrenalin was injected at first very slowly in dilute solution and later more rapidly. The systemic blood pressure at first rose very slowly and with it the extent of the excursions of brain flap became progressively smaller. As the arterial pressure rose the rate at which the blood entered the sinuses would be increased so that aspiration would have less and less effect thus causing the reduction of brain flap.

To sum up this section of the discussion it may be said that in those cases in which it was possible to induce brain flap experimentally there was one constant feature—excessive aspiration by the thorax produced by blocking partially or completely the air entry to the lungs. It seems that up to a

point the height of the arterial pressure has little effect but that once this point is passed the rate of outflow from the skull reaches its maximum and can no longer be increased by aspiratory action by the thorax.

So far attention has been confined to those cases in which brain flap was successfully produced by experiment. The very numerous cases in which the condition could not be induced have now to be considered.

In every experiment performed there was at the beginning a period in which even the most vigorous inspiratory movements of the thorax coupled with complete closure of the tracheal cannula failed to produce brain flap. At most and then only rarely a few small movements rapidly becoming smaller and soon disappearing altogether were obtained (Fig. 8). Iter on in the experiment we had no such difficulty in one experiment alone did we fail at all times to obtain brain flap.

There can be no question as to the occlusion of the tracheal cannula. The orifices were closed with finger and thumb in the same manner exactly in each case.

Lowering blood pressure by vagal stimulation with complete closure of air entry was entirely without avail. Similarly administration of histamine in order to lower blood pressure and induce a condition closely akin to if not identical with surgical shock was equally useless. The sole result of the latter procedure not invariably was to cause a reduction of intracranial volume. Again the raising of the blood pressure by the injection of adrenalin was without immediate effect.

In these experiments we attempted to vary the rates of inflow and outflow of the cerebral circulation in all possible ways. Stimulation of the peripheral end of the vagus causes a reduction of blood pressure and so a decrease in inflow with possibly an increase in the venous pressure in the sinuses. Histamine produces a lowering of both arterial and venous pressures in the skull as has been shown by Lee (5). This should produce a reduction of both inflow and outflow. Finally adrenalin as already stated causes an increase in both inflow and outflow.

As explained in the experimental section the only reliable method of inducing the con

dition was found to be the injection of adrenalin. Sooner or later after this had been done it would be found that brain flap could be induced. A point of some slight interest as showing the small importance of the arterial pressure in connection with the phenomenon is the fact that in several experiments brain flap was induced some time after the administration of adrenalin with the blood pressure standing at exactly the same figure as that at which it had stood earlier when all attempts to induce brain flap had failed.

It is clear from a comparison of the experiments that failed at first and later were successful that some change must take place in the conditions of the cerebral circulation. At first there is no brain flap or only a very slight manifestation of it which soon disappears. This means that in the normal animal inflow and outflow of blood to and from the cerebral circulation remain exactly balanced, however great may be the variation in the inspirating action of the thorax. Later on this balance becomes upset and brain flap develops. The mechanism and nature of this change is at present obscure. There seem however to be three possibilities in this connection. The first is that outflow should be at its maximum to commence with so that inspiration by the thorax cannot further increase the rate of discharge. This seems improbable in view of the facts that first inspiration apart, the principal if not the only real factor concerned with the pressure in the sinuses is the arterial blood pressure and second at two different stages in the same experiment the blood pressure may be exactly the same and yet at one stage it may be impossible to induce brain flap and at the other the condition may appear readily. The second possibility is that there may be some as yet unknown mechanism which so controls the inflow as to make it exactly equivalent to the outflow at all times, however much the latter may vary. Nothing is known of such a mechanism and having regard to the circumstances of the cerebral circulation it seems improbable that such should exist. The third possibility is based on the facts that (a) the only certain way of inducing the condition in animals was found to be by the ad-

ministration of adrenalin and (b) it is known that the venous pressure remains high for some considerable length of time after the return of the arterial pressure to the normal. It may be that the arterioles become as it were trained by the passive pressure exerted on them by the systemic blood pressure and remain dilated throughout the experiment thus enabling the venous pressure to remain high with a relatively low arterial pressure.

Again it may be that variations in the intracranial pressure may condition the change in the cerebral circulation. At present our experiments in this direction are not sufficiently complete to allow us to say anything on this point and this part of the subject is reserved for a second publication. Hill (3) states that a high intracranial pressure would tend to dump any other variations in pressure or volume within the cranial cavity.

Finally it remains to consider what if any similarity can be traced between the experimental results and the clinical finding.

Our experiments may be divided into three classes: (1) those with no brain flap; (2) those in which brain flap was represented by a few movements of the intracranial volume lever soon vanishing entirely (Figs 5 and 6) and (3) those in which brain flap was easily induced when desired.

The clinical observations may be divided into three exactly similar classes. The absence of references in surgical literature to phenomena of this kind can mean only one of two things—either brain flap is so common as to be unworthy of remark or so rare that it has been observed only on a few occasions. Considering the frequency of trephining as an operation and the rarity with which this condition has occurred in our experience it is clear that the second explanation is correct. Stertorous breathing is frequently associated with the conditions for which trephining is performed and yet brain flap is practically unknown. Therefore the ordinary trephine operation in a case in which there is some obstruction to breathing forms an exact parallel to our first class of experimental findings.

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Reference to the first section of this paper will show that in our fourth and fifth cases there was a transient appearance of brain flap. The movements were associated with deep respirations but soon disappeared. These two cases may be considered as similar to or even identical with our second class of experimental findings.

Our first and third clinical cases and probably Wheeler's case should be joined to them—displayed movements of the brain associated with difficulty of breathing which continued for some time. They are sufficiently parallel to our third class of experimental findings to permit us to suggest that there must have been similar causes at work in the two conditions. Only one important objection seems possible that in the clinical cases the condition arose apparently spontaneously but in the experimental work only with active interference. This objection we think is not well founded. It is true that in our later experimental work care was taken to block the tracheal cannula completely. This was done to give us a firm basis for our work. In the earlier experiments it was observed that brain flap could be produced by far less vigorous interference with the air entry such as might occur with excessive mucus in the trachea though the movements were then less pronounced. It is of course impossible to say how much or how little resistance there was to breathing in our clinical cases and consequently how much change in the intrathoracic pressure would occur on inspiration. We feel that with the closely parallel results that have occurred in the operating theater and the experimental laboratory we are justified in claiming that we have reproduced in dogs a condition exactly similar to the rare occurrences of brain flap observed clinically.

#### SUMMARY

1. A phenomenon of extensive changes in intracranial volume synchronous with respiration in man with the experimental production of a similar condition in dogs is described under the term brain flap.

2. In an animal just after death great changes in intracranial volume can be produced after the chest is opened if the heart

is alternately squeezed and relaxed. These changes from the mechanical conditions must be opposite in sign to those of brain flap.

3. The condition is dependent on changes in the intracranial content of blood.

4. The volume of a brain which exhibits this condition diminishes with inspiration and increases with expiration.

5. Dyspnea is a constant factor in its production both clinically and experimentally.

6. In the presence of dyspnea the condition may occur with systemic blood pressures ranging from 140 to 40 millimeters of mercury.

7. On the other hand dyspnea may fail to produce it with systemic blood pressures as low as 40 millimeters of mercury.

8. Brain flap is cut short by the marked rise of arterial blood pressure caused by intravenous injection of adrenalin.

9. Within fairly wide limits brain flap seems not dependent on arterial pressure.

10. The immediate cause of brain flap would appear to be an imbalance between the quantity of blood entering and leaving the cranial cavity from moment to moment.

11. It is certain that one and probably the main factor in this imbalance is the excessive aspiration of blood from the veins by the chest during dyspneic respiration. It is probable (a) that a relatively deficient inflow to the cranial cavity from the arterial side may be an essential factor and (b) that while a high pressure of the cerebrospinal fluid will damp the movements of the brain a fall in pressure may permit them to appear.

Much valuable assistance in the experiments was given by Dr. K. S. Maan, M.Sc. Th.D. and the authors wish to acknowledge their debt in a spirit as wholehearted as that which prompted the aid.

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# CLINICAL SURGERY

FROM THE ORTHOPEDIC SERVICE OF THE MASSACHUSETTS GENERAL HOSPITAL

## FUSION OF THE SPINAL COLUMN

P. NATHANIEL ALLISON, M.D., F.A.C.S., B.S.T.

**A**n operation the purpose of which is to create bony union between several vertebrae is indicated when either injury or disease has caused or is causing a destruction of one or more vertebral bodies. It is also indicated when the spinal column is curving laterally as a result of paralysis of the muscles or of congenital defects in the bones.

The lesions which present the chief indication for spinal fusion are tuberculosis of the adult spine, compression fracture of the spine, scoliosis which results from poliomyelitis and scoliosis due to congenital bone defects.

### DANGERS AND POSSIBLE COMPLICATIONS

The operation demands a thorough exposure of the posterior spinal arch throughout an extensive area.

The chief danger is that of surgical shock or operative infection. Infection is a most serious and menacing danger against which every precaution in the way of careful operative technique and complete asepsis of technique is to be taken by the surgeon. There is little danger of serious hemorrhage and little danger of damage to vital structures provided the operation is carefully done.

### PREPARATION OF THE PATIENT

The patient should be given rest in recumbency for several days before operation is undertaken. During this period he should receive the maximum of quiet and restful sleep with light diet and free catharsis. The bed should be firm and unyielding and only one pillow should be used.

The operative fields are the entire back and the tibial surface of one of the legs. The back should be shaved, scrubbed with soap and water and cleansed with ether and alcohol the day before

operation. The leg should be prepared in the same way.

The choice of anæsthesia rests with the surgeon. Ethylene or ether seem to us to be best suited for this operation.

The patient is placed face down on the operating table. To secure comfortable breathing in this position and to lessen surgical shock, the use of the cerebellar table is recommended (Fig. 1).

The back and one leg are exposed and painted with iodine. The leg is flexed at the knee so that the heel rests near the buttock of the same side (Fig. 2). This exposes the anterior tibial surface. The table and leg are draped with sterile sheets. It is quicker and there is less consequent shock if the two operative procedures are carried on simultaneously (Fig. 3). The operator and his assistant prepare the spine for fusion while the second operator and his assistant remove the graft from the tibia.

### STEPS OF THE OPERATION

1. An incision is made in the midline over the tip of the spinous processes. The area of the spine to be fused has been determined by previous study of roentgenograms. Two vertebrae on each side of the vertebrae principally involved should be included. This means that provided the tenth and eleventh dorsal are chiefly involved, then the fusion should include the eighth and ninth above and twelfth dorsal and first lumbar below. The incision therefore should expose the spinous processes of the eighth dorsal to second lumbar vertebra inclusive.

After the division of the skin by vertical incision directly over the tips of the spinous processes the posterior spinal ligament is exposed. The tips of the spinous processes are clearly seen and felt. The ligament should be divided accurately in true vertical line in the middle of each spinous process. This is best done by securing each spinous process in the grasp of a curved clamp and making a vertical knife cut in the

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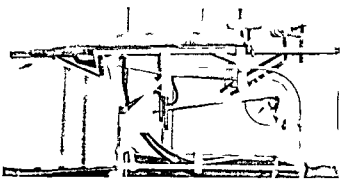


FIG. 1. The cerebellar table which consists of a head rest and two shoulder supports. If the patient is placed face downward on the table as is necessary in the spinal fusion operation surgical shock is increased by the fact that each forcible movement on the spine itself is transmitted to the patient's abdomen. By the use of the shoulder support and the head rest the weight of the operation is transferred to the shoulders thus protecting the abdomen and chest. Another valuable feature of this table is that it holds the spine in a straight position.

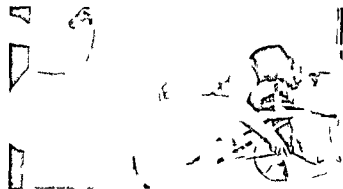


FIG. 2. The patient placed on the cerebellar table with the head supported. The operation is started and the back and the legs are prepared for the operation.

Bleeding is checked and controlled by tight packing, narrow gauze strips being used.

4. *Suture* The edges of the supraspinous ligament are sutured together over the entire area with interrupted sutures of 30 day chromic catgut No. 2 or with silk sutures. The skin wound is closed with interrupted sutures of silk.

#### REMOVAL OF THE OSTEOPLASTIC GRAFT

While one operator is preparing the bony bed on the posterior side of the spine the second operator removes the osteoperiosteal graft. He has as a rule time to do this in a leisurely manner as it takes longer to prepare the fusion bed. He should not anticipate the preparation of the spine because it is a valuable piece of technique to transfer the graft immediately to its future bed without delay and unnecessary handling. The graft should be cut free at the moment the spinal bed is ready and at that time transferred.

1. Incision is made from the tibial tubercle to a point 2 inches above the internal malleolus. The

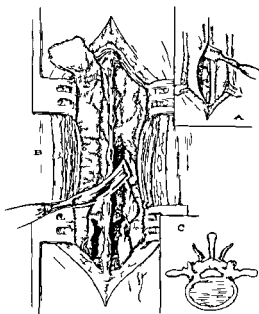
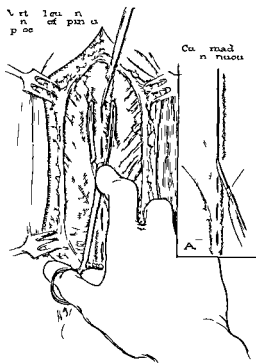


FIG. 3. One operator has the patient as he is held of position. The second operator is preparing to remove the tibial graft. The leg is held steady by the use of a sterile bandage which is passed around the end of the table.

mid sagittal plane of the spinous process (Fig. 4). From this entrance point the muscles, fascia and periosteum may be stripped from the side of the process and along the laminae below. The splits in the processes are united by a longitudinal incision throughout the region to be exposed (Fig. 4 A).

By blunt dissection with a periosteal elevator (Fig. 5 A) and by gauze packing (Fig. 5 B) the entire posterior arch of the spine is then exposed. Retraction is accomplished by deep retractors and later when the posterior arch of the spine is exposed by self retaining retractors (Fig. 5 B).

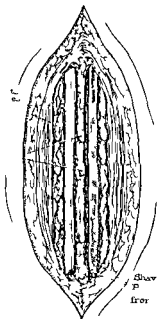
3. *Preparation of bony bed* From the surface of each lamina down as far as the lateral articulation a bone shaving is turned up with a curved chisel. The lateral articulation is entered with the chisel and small curette and the articular cartilage of the articulation removed. Each spinous process is split longitudinally into 3 fragments with a chisel and the spinous process is cut across at its base so that these fragments may be broken down to lie in position overlapping the space between the spinous process above and the spinous process below thus bridging the entire area of the posterior spinal arch with bone fragments each of which is still loosely attached to a base. All of these fragments are flattened out so that the surface is a rough surface for fractured bone fragments continuous from the upper limit to the lower limit of the area to be fused. On each side of the midline a osteoperiosteal graft from the tibia is now placed bone side down. Two strips of osteoperiosteal material  $\frac{1}{2}$  inch wide and long enough to reach the limits of the denuded area.



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Shaving of  
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entire subcutaneous surface of the tibia is exposed. It is well to mark out the graft with 2 longitudinal incisions made with a knife through the periosteum well into the cortical bone. The graft should be 1 inch wide and should be long enough to reach over the entire spinal area. It should be as a rule about 6 to 8 inches in length—this may be definitely decided by the use of a measuring probe supplied by the operator at work on the spine.

A sharp chisel the width of which is exactly that of the marked out graft is started at the upper end with a mallet. This chisel is engaged in the bony surface of the tibia and by repeated light taps with the mallet a shaving is rolled up (Figs 7 and 8). It is important not to cut out with the chisel but to keep the edges of this instrument engaged in the subperiosteal bone. As a result the shaving removed should have periosteum on its upper surface and its under surface should be made up of a layer of subperiosteal bone 1/6 to 1/3 inch in thickness. This strip 1 inch wide is then cut longitudinally making 2 strips 1/2 inch wide and these should be transferred to the first operator for implantation in the bony bed.

The wound over the tibia is sutured with interrupted silk stitches and a tight compression bandage applied.



FIG. 7 (left) The removal of the osteoperiosteal graft. The subcutaneous surface of the tibia is exposed. The chisel is started at the lower end through the periosteum into the subperiosteal bone.

FIG. 8 The removal of the osteoperiosteal flap. By gentle blows with the mallet a shaving of osteoperiosteal material is turned up from the anterior surface of the tibia. This is divided into two pieces which are transferred to the pelvic field for implantation.

#### POSTOPERATIVE CARE

As soon as the operation is over—it should be done in about 1 hour or less—an estimate of the patient's general condition should be made: pulse rate and blood pressure compared to pulse rate and blood pressure before. The anesthetic chart is very important because the operation has peculiar possibilities of creating surgical shock. In all instances whether or not shock is evidenced the patient should have shock treatment. He should be returned to bed as soon as possible. Heat elevation of foot of bed, shock enema, forced fluids, subdermal fluid if necessary, and morphine in sufficient quantity should be employed. If at the end of several hours there is evidence of postoperative shock, blood transfusion is indicated and 500 cubic centimeters of suitable blood should be given. The blood donor should be available during the first 24 hours after spinal

fusion is performed. We have not found it necessary to place these patients on frames or in apparatus such as braces or plaster of Paris shells. A firm mattress is all that is necessary for the first 10 days. The use of pillows should be avoided.

After the removal of the sutures and when wound healing is established the patient should be supplied with a suitable brace or a plaster of Paris shell.

Absolute recumbency is necessary for a period of from 8 to 12 weeks. The patient should not be allowed up until a suitable jacket of plaster, leather or celluloid or a proper metal brace has been adjusted. The period of being up and about is gradually increased from  $\frac{1}{2}$  hour to full activity. Support and protection of the spine as well as carefully planned supervision of activity is necessary for at least 1 year after the operation.

FROM THE GYNECOLOGICAL CLINIC OF THE UNIVERSITY OF GHEENT

## INTRA-ABDOMINAL INCISION OF THE VAGINAL VAULT FOR DRAINAGE

BY DR. G. BAETEN, CANT. BELGIUM

A. D. I. R. I. C. D. p. m. f. h. G. I. g. I. C. I. f. t. h. L. r. s. y. f. G. h.

Our modern aseptical and anti-septic methods have made the use of extensive drainage less common than formerly. Even in a severely infected case it is advantageous to close the abdomen completely although if hemorrhage persists or the vaginal surface is abraded and necrotic tissue remains one will not hesitate to make use of extensive drainage.

Extensive drainage is to be recommended chiefly after ablation of the adnexa in the presence of many adhesions after operation for carcinoma of the cervix for hæmatocele or for adherent necrotic tumors. When it is only a matter of arresting a hæmorrhage pressure can be produced with a tampon and the drain can be brought out side along the lower part of the abdominal incision so that it may be removed after 4 to 36 hours. In such cases we always inject paraffin oil mixed with 10 per cent oil of camphor.

However when the wound surface is large or considerable necrotic tissue remains it is essential to use more extensive tamponade and drainage through the pouch of Douglas and the vagina. In this procedure several mistakes are commonly made. In an attempt to secure drainage of the pelvis through the pouch of Douglas it is not easy to open the vagina with curved scissors and often the tissues are irregularly cut and bruised.

After supravaginal hysterectomy it is difficult to open the posterior vaginal arch. When a long

curved forceps has been introduced into the vagina it is necessary for the operator to guide an assistant's hand in the protruding of the posterior vaginal arch by means of the instrument. After cutting through the posterior vaginal arch we sometimes have to cope with hemorrhages from the vaginal wound. Therefore it is wise to place a suture at the right and left sides on the edges of the vaginal incision although it may be difficult to do this because the edges of the vaginal incision lie deep in the pelvis.

In order to avoid some of the usual difficulties we have made use of an instrument which consists of two movable arms held together by means of a set screw. The curved arm carries a sphere which is introduced into the vagina as far as the posterior vaginal arch shortly before the operation after the abdominal wall and vulva have been disinfected (Figs. 1 and 2).

During the operation the surgeon can move the handle of this instrument so as to make the posterior vaginal arch protrude into the abdominal cavity and extend upward so that it can be reached quite easily (Fig. 3). On the sphere there is a longitudinal and a transverse furrow; the former facilitates the incision in a forward or backward direction; the latter serves to pull the thread on the right or left side through the edge of the vaginal incision so that it cannot glide off the smooth surface of the sphere. The transverse





Fig. 4 Another attachment and forceps

Fig. 5 Application of instrument

Fig. 6 Instrument in use

furrow is also useful when a transverse incision is used in a total hysterectomy. In the foremost part of the longitudinal furrow there is a little bridge around which can be turned the end of a drain or to which a thread may be attached that will carry the drain into the vagina when the instrument is withdrawn.

A similar attachment but provided with a crowbill and different forceps which can be hooked on to a portion of the vagina is also very useful (Fig. 4).

Figure 5 illustrates the manner in which the forceps is fixed and the other part of the instrument is screwed upon the handle of the forceps so that at any given moment the operator may seize the handle of the instrument and at once bring to

his hand in the abdominal cavity a well defined part of the vaginal wall (Fig. 6).

The Muesauz forceps has the advantage that when pressure is exerted on the instrument the forceps will not pierce the tissues. In ovarian implantation the instrument can be used to draw an ovary into the uterus by means of a thread.

The seizing of certain parts of the vaginal wall chiefly the foremost vaginal arch and the possibility after laparotomy of recognizing distinctly this part of the vagina and of pushing it upward is extremely advantageous in Wertheim operations for carcinoma of the cervix and even in cesarean operations when a drain is to be placed in front of the incision in the uterus and led downward along the vagina.



# AFTER-TREATMENT OF PELVIC AND ABDOMINAL SURGICAL CASES<sup>1</sup>

B RALPH WORRALL M.D. M.C. I.A.C.S. (HON.) S.D. AUSTRALIA  
C. I. G. I. t. h. S. d. y. H. o. s. I. S. g. h. C. I. I. p. t. l.

In the early days of pelvic and abdominal surgery the preparation and after treatment of the patient were considered of importance almost equal to that of the operation. Now the pendulum has swung in the opposite direction and we do not hesitate to operate in the suburbs or country and leave the after treatment absolutely to the discretion of the local practitioner.

In a large proportion of instances the patient does not suffer any material injury from this ideal responsibility but every once and again it happens that the absence of the shepherd who owns the sheep the operator himself leads to disastrous result. I wish to cite some post-operative complications in which close follow-up by the surgeon averted failure and dashed death aside. The cases have been selected as illustrating different conditions and the treatment adopted.

Secondary hæmorrhage following plastic operations on the cervix and vagina is usually caused by too tight or non-absorbable sutures and need prompt and skillful treatment. The patient should be placed across the bed the vagina should be thoroughly irrigated with a solution of hydrogen peroxide until all clots have been removed. Thin narrow bladed retractors should be passed anteriorly and posteriorly and a firm gently placed pack with iodine gauze should be carried out. The foot of the bed is then raised 18 inches. If this does not control the bleeding the patient is anesthetized and the bleeding point exposed by the narrow bladed retractors and a catgut suture or sutures passed beneath it with a handled needle. In such circumstance a handled needle is much more effective than a needle on a holder. I have practiced this procedure on several occasions without interfering with the successful result of the operation.

Secondary hæmorrhage (intrapræcervical) is an untoward occurrence which I have not seen in the last 3 years. Separation of ligaments of vessels and abandonment of mass ligation has abolished it.

Suppuration of an abdominal wound occasionally occurs after an operation for cancer of the cervix uteri or suppurative conditions. It may also result from the suppuration of a hæmatoma as a result of bleeding from a small vessel in the

parietes which has escaped notice and ligature. It should be suspected if there is a persistent evening rise of temperature not associated with other serious symptoms. The supporting sutures being left intact the line of incision which has probably healed perfectly is gently palpated and when tenderness or a soft spot is detected a sharp pointed scissors is inserted an opening made and the pus evacuated. The pocket is rarely beneath the aponeurosis. If it is of any size a small drainage tube may be inserted and given very gentle irrigation with peroxide of hydrogen daily.

## BURSTING OPEN OF AN ABDOMINAL WOUND

Case. After my third wound was closed by Catgut sutured the patient made good progress but on the 14th day the wound burst open. The patient was lying on her back and the wound was about 4 inches long and 1 inch wide. The edges of the wound were clean and the underlying organs were exposed. The patient was in good health and the wound had healed perfectly. The patient was lying on her back and the wound was about 4 inches long and 1 inch wide. The edges of the wound were clean and the underlying organs were exposed. The patient was in good health and the wound had healed perfectly.

## PELVIC SUPPURATION

Case. M.D.M. s.l.d.m. No mb. 9. f.g. h.e.l. d.v.t.s. d.th.t. of m.th. t.d.g. Th. h.d.be. m.h.g.f. l.y.rs. O.N.m.b. S.k. e.t.b. i.t.p.d.c. t.r.z.d. t.d.b. C. l.m.c.s. ompl.t.ly. d.by. Am J Ob. & Gy. 9.7.1. N. 6. f.h.N. S. h.w.les.B. h.f.th.B. h.M.d. I.A.o.c.t.

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modified Sturmdorf technique. The tubes were thickened and somewhat reddened but fimbriated ends were not closed. Milking of the tubes failed to express any discharge. The patient was fixed to avoid stenilization, the tubes were not removed. A retroversion was corrected by suturing the round ligaments behind the uterus. The highest temperature after the operation was 100 degrees and the highest pulse was 96 but neither became quite normal and the patient felt depressed and ill. On the tenth day 3 pints of pus were evacuated from the lower angle of the wound without benefit. On the nineteenth day the patient began to complain of rectal tenesmus. Examination disclosed a small collection in the pouch of Douglas. Under the posterior fornix was incised about 3 drams of pus as evacuated and a split rubber tube inserted. Rapid recovery followed. The patient was seen again on September 19, 1916 that is nearly 5 years after the operation. She had been fairly well except for nervousness which was attributed to excessive menses. There had been no dysmenorrhea or abnormal discharge since operation. Examination showed a normal cervix. The appendages were slightly enlarged and slightly tender. The patient had been in with the same lover ever since but a condom was always used in coitus.

This case demonstrates how treacherous a gonorrhoeal infection always is and what a risk is taken when an attempt is made to preserve the tubes under such circumstances. It is probable that she would not conceive even if the use of condoms were discontinued. A total hysterectomy would have left her in better health provided the ovaries were not removed.

CASE 2 Mrs. G. B., 34 years of age, a nullipara, consulted me on January 9, 1914 for pain in the lower abdomen, rectal tenesmus, and dysuria which had troubled her for 2 days. There had been 3 similar attacks preceding the last 3 periods. Temperature was 101.4 degrees, pulse 100. Vaginal and rectal examination disclosed a myomatous uterus and a tender fixed mass in Douglas's pouch. The ovaries were inflamed or suppurating, ovarian cyst complicated by myoma.

On January 11, under ether posterior vaginal celiotomy was done and the supposed cyst was carefully separated. The abdomen was then opened and subtotal hysterectomy was performed, both appendages which were normal being left. The supposed cyst proved to be an enlargement of the pelvic colon hard and nodular resembling a malignant growth. The bowel as divided well above and below the growth and after thorough removal of the latter with the surrounding tissue the bowel ends were reunited by the Rutherford Morrison method—passing a large tube down through the anus, suturing the upper end in the proximal bowel making traction on the lower end and invaginating, the upper end of the bowel into the lower, then suturing with fine chromic gut. A small rubber and gauze drain was passed into the vagina through the vaginal celiotomy wound.

The bowels moved by castor oil in 50 hours. The bowel tube and drain were removed on the eighth day. Temperature and pulse continued as before the operation. On the eleventh day a small quantity of pus was evacuated from the lower angle of the abdominal wound and there was a temporary drop in temperature. On the seventeenth day a nurse took place and the temperature rose to 104 degrees, pulse 104. Micturition was frequent and painful and the urine showed a trace of pus. Vaginal examination disclosed a slightly tender exudate in the anterior fornix.

Under ether the bladder was dissected up and the finger pushed into a collection of pus in the uterovaginal pouch. A split rubber tube was inserted here and another in the old opening in the posterior fornix dilated for the purpose. After this there was an immediate improvement in all the symptoms. The rubber tubes were removed on the fourth day and the patient left the hospital 6 weeks after the original operation feeling very well.

Professor Welch reported the specimen to be one of diverticulitis. One of the most remarkable I have ever seen there are only two diverticula—one extends beneath the peritoneum and is on the point of perforation, the other has also penetrated beyond the muscular coat into the mesentery, here a small necrotic abscess has developed.

When as in this case it is not possible to lift the bowel out of the pelvis so that it can be segregated prior to resection it is difficult to guard against infection and suppuration. On March 31, 1915, 15 months after operation the patient reported as having had no trouble since. A tedious follow-up had saved the life.

# POSTOPERATIVE INTESTINAL OBSTRUCTION

Vigilant watch should be kept for the dangerous complication of postoperative intestinal obstruction. Promptness is the very essence of its successful treatment. If vomiting associated with paroxysmal pain occurs in a patient who has been doing well for a week or so and if two large enemata fail to bring away flatus and feces with relief from the symptoms within 12 hours a diagnosis of intestinal obstruction should be assumed and appropriate measures taken without delay. In the following case and another exactly similar to it I adopted a method of treatment which is not mentioned in any of the well known textbooks and which in these cases was attended by success. The method is worth bearing in mind but should be used with discrimination. The surgeon must be in a position to exclude definitely peritonitis or suppuration.

CASE 1 Mrs. Z., age 44 years, as admitted to the Lister Hospital January 1923 suffering from hæmorrhage due to myomata. An operation had been performed by another surgeon several years previously for retention and salpingitis. I did a total hysterectomy leaving both ovaries (the tubes had been removed at the previous operation). Moderate adhesions were present. The patient collapsed easily until the sixth evening when she was seized with paroxysmal pain and vomited several times. Two large turpentine enemata during the night failed to move the bowels or bring away flatus. When I saw her the next morning she looked anxious but not very ill. Pulse 100, temperature 99.6 degrees. The abdomen was moderately distended but not tender. Vaginal and rectal examinations disclosed nothing abnormal.

While preparations were being made for the reopening of the abdomen I thought I would try succussion. Standing on the bed at the foot I seized the patient's legs beneath the knees and lifted up her body so that she rested on the back of her neck and shaded by the spring mattress I gave her three fairly violent shakes. Another large turpentine and soapy water enema was then administered. This acted promptly and brought away faecal matter and much flatus. The subsequent convalescence was uneventful.

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day the vomiting returned and distention increased and the pulse rose to 100 and was very quick. The patient's arms were quite cold and she seemed moribund. When I saw her at 8 p.m. the rectum was given an irrigation with made in the right iliac region. A distended loop of ileum came to the surface and was pulled out and a rubber tube was inserted into its lumen by the technique described in a previous case. The patient was quickly returned to bed no worse than before the short operation.

On the next day the nurse the patient was distended better. Much flatus and liquid foul smelling. Feces were evacuated through the tube. Vomiting ceased. On the tenth day the bowels were loose the pulse was 104 the patient was in good condition but felt low. On April 6 the fourteenth day after the first operation and the seventh day after the insertion of the tube into the bowel the tube was removed. The median wound was suppurating the patient looked dull and poisoned pulse was only 100 and the temperature was normal. After this progress was steady and on May 29 65 days after the first operation the patient was discharged feeling well. The right iliac wound had suppurated and was not quite healed. A probe could be passed into the bowel. Six weeks later the patient reported wound healed and felt well. On July 2 1922 2 years later the patient consulted me for an attack of epistaxis. She was otherwise very well. There was a slight hernia in the lower end of the median scar. The pelvis felt normal except for the absence of the uterus. I think it would have been better at the second operation to have done an enterostomy and have left in a tube instead of attempting to empty the bowel by puncturing and suturing the openings.

In the foregoing histories the symptomatology of postoperative intestinal obstruction is well exhibited. The patient does well for a few days or weeks and then suddenly vomits and complains of proximal pains. Flatus ceases to pass and the bowels cannot be properly moved. The temperature and pulse remain unaffected for a time. There is increasing abdominal distention but no great amount of tenderness.

The patient's life depends upon unhesitating action. If two enemata fail to bring relief succussion as described should be tried. If this is unsuccessful the abdomen should be opened the hand passed into the pelvis and all small intestines lifted up and inspected. If the contents of the distended bowel can be easily milked into the collapsed bowel probably all will be well if not an enterostomy should be done. Puncturing of the distended bowel in several places involves too great a risk of infection. I have not tried Handley's ileocolostomy with cæcostomy or Bonney's jejunostomy. The passing of the enterostomy tube through the omentum as advised by Dr. Wesley Long is a device worth bearing in mind.

I am inclined to think that many cases of paralytic ileus with peritonitis may own a mechanical basis or be associated with a mechanical obstruction and that a timely enterostomy might have saved some of my much regretted fatalities. It is now generally recognized that in death from

peritonitis the patient is poisoned by absorption of the toxins formed in the stagnant intestinal content. This suggests enterostomy as the most hopeful treatment.

# ACUTE DILATATION OF THE STOMACH

CASE 1. M. J. M. 60 years old was examined on October 6 1909 and complained of attacks of gastric pain accompanied by vomiting for 3 years. Morphine had been necessary but without gain. Vomiting did not relieve the pain. It had continued to terminate an attack. The patient had lost weight and felt weak. X-ray examination report suggested gall stones with gall bladder adherent to transverse colon and pyloric ulcer of the pyloroduodenal junction.

On October 19 1909 cholecystostomy was performed and the gall harpelled gall tone was removed. A tube was introduced into the gall bladder without attachment to the junction. Acute inflammation of the normal epithelium had happened. The patient's condition was free from vomiting. The stools showed no malodorous appearance. On the thirteenth day the patient had a free evacuation of mucus and quiescence. At first later the distension seemed to subside. From the mouth there was no pain or tenderness and no pyrexia. The rectum contained no bile. The bowels moved easily by enemata. Distension was present in the upper abdomen but not in the lower. The pulse was 100 to 120. Blood cells few in the sputum.

The patient was placed in the prone position the foot of the bed raised 18 inches. Titration of stomach and the minimum amount of food was given. The stomach was held out several times daily. The vomiting gradually abated but continued mucus stools for 10 days and irregular evacuation for the next 14 days. The patient was quiet 116 hours from the day of operation.

CASE 2. M. S. A. 44 years old complained of nasty dyspepsia profuse mucus a little vomiting periods of anorexia and loss of weight. The patient was a nurse. She had a history of a hysterectomy. On June 17 1914 the patient was taken away by a male nurse. Admitted to the hospital. The patient was conscious and lucid. The face of the tumor that appeared on the left side of the face of the patient was 92 degrees. Partial incontinence of urine lasted for 48 hours after operation.

On June 20 the patient was still vomiting but the bowels acted well after enemata. The pulse was 84 and the temperature 99 degrees. The patient was given relief for 12 hours then vomiting resumed. The patient repeated and again the vomiting ceased. On June 22 the patient enjoyed a breakfast of eggs and toast but at 10 p.m. there was a sudden attack of epigastric pain and vomiting followed by collapse. The pulse was up to 160 and was thready. The stomach tube was inserted 10 or 12 pints of dark fluid and immediate improvement followed. I thought by hypodermic use of eserin strychnine and digitaline the raising of the foot of the bed 18 inches the keeping of the patient in the prone position and the administration of rectal saline every 4 hours. The vomiting ceased after this. The stomach tube returned no fluid. The stomach. Next day the pulse was 118 and had a good volume. No further vomiting occurred until the tenth day when it returned and was again controlled by lavage. It returned again on the thirteenth day and the tube evacuated over a quart of dark fluid with explosion of gas.

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It is to be noted that in one case the symptoms of dilatation commenced on the thirteenth day and in the other on the fourth day. The diagnosis is not difficult the bowels are unaffected

while the sudden onset epigastric pain collapse and effortless vomiting of large quantities form an unmistakable clinical picture. The only effectual treatment is as described in the case histories.

In considering postoperative complications prophylaxis must not be forgotten. Perfect hæmostasisis careful operating the use of quick methods and not quick movements and asepsis will minimize the occurrence of these untoward events.

One word on a different aspect of the subject. In the treatment of all disease we are fighting a losing hazard. Sooner or later death will triumph and will seize the Doctor too. In that hour the dominant note should be infinite compassion. This should prevail over all other considerations. Morphine must not be spared. In the words of Dr Robert Hutchinson. When our time comes let us hope we may fall into the hands of a doctor who knows the value of morphia.

## THE SURGICAL IMPORTANCE OF X-RAY EXAMINATION OF THE OESOPHAGUS AND THE PHARYNX

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AND

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Chief of the X-ray Laboratory

## THE OESOPHAGUS

THE diagnosis of diseases of the oesophagus has progressed surprisingly since the dawn of the roentgen era. Up to that time the oesophagus could be examined only by means of sounds, a method which must be looked upon as not altogether harmless for the patient (aneurisms, diverticula), quite apart from its inconvenience and frequently faulty results. At about the time X-ray diagnosis appeared, medical diagnosis was also enriched by the addition of the method of oesophagoscopy, the importance of which is generally recognized in the surgery of foreign bodies of the oesophagus and extractions in general. This method has served us well in the search for important findings in pathological conditions of the oesophagus.

X-ray examination of the oesophagus is painless, harmless, convenient and very valuable. The method depends, as is well known, on the fact that the contrasting agent, the paste, is swallowed while the patient is standing upright and is held for a longer or shorter period of time at the level of the stenosis (we will consider stenoses almost exclusively in this paper). This affords us knowledge as to the upper level of the stricture. We can also make important conclusions as to the nature of the process on the basis of the type of the picture. The results obtained by a fluoroscopy in upright position (these can be completed by a plate) are nevertheless lacking in certain important diagnostic facts. Such an examination gives us a good view of the upper border of the process, but it does not inform us as to the extent of the condition in the oesophagus, since the contrasting mixture passes through the oesophagus in a regularly narrow line. In order to fill this great need in oesophagus diagnosis, our clinic pointed out (6 and 7) the importance of X-ray examination of the oesophagus in cases of stricture in horizontal position of the patient. The patient swallows the contrasting mixture after taking up a horizontal position. The transportation of the mixture through the incompletely stenosed oesophagus is a slow one in this horizontal position and the result is a complete filling of the oesophagus. In incomplete stenoses

this means not only a cast of the contours over the stricture, but also within and below the area of stenosis. Although this method of examination is of little value in tumors of the thoracic section of the oesophagus because of the dubious prognosis of operation in such cases, it is all the more important in cicatricial strictures. An X-ray examination of an incomplete cicatricial stricture of the oesophagus in this way gives us an idea as to the upper level of the stricture, its length and form. In short, we are no longer in the dark, but are now in a position to learn whether a stenosis is extensive or small, and this gives us a better foundation for the endoscopic treatment of the scar.

In examining the patient in a horizontal position, it is better to irradiate from a purely lateral position than from an oblique one, as we have previously mentioned (4) for the examination of the trachea following *Illienfeld's* suggestion for the lateral photography of the sternum.

The patient lies completely on one side (1) at an angle of 90 degrees to the table. The shoulders are drawn firmly backward in order to remove the almost impermeable humeral epiphyses from the field of irradiation; the arms are drawn back and the hand clasped firmly to the other. In this position, with the humeral epiphyses directly over each other and the knees drawn up, the patient is fixed on his side. The head is supported by means of sandbags so that it is in normal position. The plates are 24 by 30 centimeters. The central ray falls on the midpoint of the distal clavicle and strikes the midpoint of the plate in the line of its projection (this is for the examination of the cervical section and the proximal portion of the thoracic section of the oesophagus). In order to examine the distal portions of the oesophagus, the plate and the tube must be displaced a suitable distance distally and the focus must be correspondingly lower.

While lying in horizontal position the patient swallows a contrasting mixture of medium consistency. Before a plate is made the patient is examined on the trochoscopes under fluoroscopy in horizontal side position. At this time one can observe how long it takes from the time the paste is swallowed until the oesophageal defect is completely filled. After the preliminary fluoroscopy the plate is made with the Bucky-Potter diaphragm while the patient is swallowing more of the contrasting mixture. The plate should be

taken at a moment after the swallowing act has begun the exact time having been judged during the swallowing at the preliminary examination (the inter allet between the beginning of swallowing and the snapping of the plate is between a quarter and a whole minute). It may appear more practical to me to combine the trochoscopic examination and the plate by snapping the latter during a satisfactory moment. This of course dispenses with the Buckle Potter diaphragm.

Figure 1 illustrates the value of X-ray examination of oesophagus tumors in horizontal position. The lateral picture shows the location and topographical relationship of the tumor, the length and the length of the stricture as well as the shape of the oesophagus above and below the stenosis are also clearly depicted. We definitely see not only the upper but also the lower border of the stricture. It is often possible in the lateral projection as in this case to portray the tumor itself which stands out against the less dense lungs. Therefore this is definitely an oesophageal tumor which is localized in the proximal part of the thoracic section causing an incomplete stenosis of the tube. The stenosis begins somewhat below the level of the upper thoracic aperture and reaches about the level of the bifurcation. The thoracic section of the trachea is pushed forward and is compressed from behind.

As we have already mentioned the information obtained on the form of incomplete cicatricial stricture of the oesophagus by means of lateral irradiation is much more important than the results in the study of the tumors. Examination in upright position gives us information only on the upper level of the stenosis with orientation as to the lower portion of the oesophagus. In the event that the stenosis is only a small portion of the tube it is important to know this. We must also ask ourselves whether the stenosis extends or not, what the shape of the stricture is and at what points passage is still possible. The question must be definitely answered before any purposeful operative treatment can be undertaken. The better we know the condition present the better will be our results in treatment.

The advantages of examining the patient in the horizontal position as against the upright position are illustrated in Figures 2 and 3. They demonstrate clearly the structure of the proximal portions of the oesophagus following hydroxide cauterization. In Figure 2 (examination in upright position) the contrast medium is seen to collect at a point above the bifurcation below this point there is a thread like filling down to the cardia. The picture gives no information as to whether the whole

oesophagus down to the cardia is stenosed or whether only a small section of the tube is affected. Figure 3 (examination of the same patient in horizontal position) the contrast medium swallowed in horizontal position shows that the stricture is only very short, that the oesophagus widens normally centimeters below this point. The stricture is due to a cicatricial shrinkage which has drawn the anterior wall of the oesophagus toward the back. A small passage corresponding to the posterior wall of the tube has been left. We are thus able to learn the length of the stricture, its form and the point at which a passage has been preserved (in this case along the posterior wall). Two centimeters below the upper level of the stenosis there is again a normal breadth to the lumen. The greater width of the oesophagus above the stricture is the result of a compensatory widening above the stenosis.

Figure 4 shows how well the X-ray examination of the patient in horizontal position can reveal finer stenoses of the oesophagus (scar stricture following cauterization). Despite the unusual narrowness of the oesophagus in this case there is seen a complete filling of the tube not only above but also below the stricture so that we have a complete picture of the cicatricial shrinkage in the oesophagus. It is natural that only incomplete stenoses of the oesophagus are to be considered for examination in this way. For if the stenosis were complete its form could be definitely cleared up only by a simultaneous filling from above and an oesophagostomy from below through a gastrotomy. Sometime we can also get a general idea as to the length of a scarred stenosis by examining in horizontal position without filling the oesophagus. The lateral view of the cicatricial tissue discloses the latter to be longer than the air-filled lungs.

We must also mention the case of a congenital partial pharyngeal stenosis. The patient was a 1-year-old boy who had always suffered from marked swallowing complaints. X-ray examination with the patient in upright position (Figure 5) showed the transient collection of the contrast mass in the oesophagus at about the height of the bifurcation. The oesophagus was rather markedly dilated above this point but from this level downward the oesophagus was seen only as a thin thread. Here again we were unable to decide whether the stricture reached as far as the cardia or not. Figure 6 was made with the patient in the horizontal position (the patient swallowed the paste in this position). It shows that the stenosis is 6 centimeters long and that below the stricture the oesophagus is again normally dilated (at 1). But this examination disclosed still another interesting point and

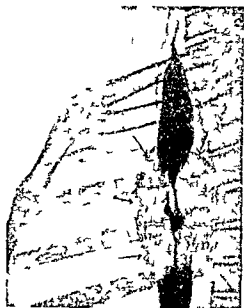


FIG. 1. Oesophageal tumor examined with the patient in horizontal position. The patient swallowed the paste in this position. The original photograph is at the right, the left at the left. One can see the upper and lower poles of the stricture and the form and extent of the tumor. The tumor itself is clearly visible in this projection (marked by the arrows). The thoracic portion of the trachea is compressed from behind.

that is the presence of a second stenosis of the oesophagus somewhat below the height of the upper border of the sternum (at B). This stenosis was hardly visible in the examination in upright position.

X-ray examination of the oesophagus in horizontal position is not only valuable for the study of strictures but also in the diagnosis of pathological dilatations especially since bulgings of the oesophageal wall as Klobier (2) has already mentioned fill themselves much better with the contrasting paste in horizontal position than in the upright one. The double Figure 7 illustrates these conditions and demonstrates a large *pressure diverticulum* at the height of the cricoid cartilage which as is visible in lateral view takes its origin at the posterior wall of the oesophagus in the cervical portion of the latter. The oesophagus has been pushed forward by the diverticulum and has also been quite badly compressed from behind.

The X-ray examination in horizontal position is however more important for the diagnosis of

*traction diverticula* than that of *pressure diverticula*. The former are not infrequently revealed only by this method of examination since a more complete filling of the oesophagus is attained in the method as a result of the slower passage of the contrasting paste (this was the reason why Palu<sup>3</sup> (3) recommended the examination of patients with traction diverticula in raised pelvis position). We remember a few cases of middle aged persons with swallowing complaints in whom we suspected carcinoma of the oesophagus. X-ray examination in horizontal position showed that the cause of the stenosis was an acute angled bulging of the oesophageal wall a traction diverticulum. These traction diverticula can sometimes even lead to severe symptoms of stenosis as we were able to observe in a middle aged woman who also had a kyphoscoliosis resulting from a vertebral caries in the earliest years of life. The patient suffered from frequent and increasing complaints in swallowing which finally reduced her to a liquid diet. X-ray examination in upright posi-



taken at a moment after the swallowing act has begun the contrast time having been judged during the swallow at the preliminary examination (the interval between the beginning of swallowing and the snapping of the plate is between a quarter and a whole minute). It may appear more practical to some to combine the trochoscopic examination and the plate by snapping the latter during a satisfactory moment. This of course dispenses with the Bucky Potter diaphragm.

Figure 1 illustrates the value of X ray examination of esophagus tumors in horizontal position. The lateral picture shows the location, size and topographical relationships of the tumor, the degree and the length of the stricture, as well as the shape of the esophagus above and below the stenosis are also clearly depicted. We definitely see not only the upper but also the lower border of the stricture. It is often possible in the lateral projection in this case to portray the tumor itself in high contrast, but against the less elongated. Therefore this is definitely an esophageal tumor which is localized in the proximal part of the thoracic section causing an incomplete stenosis of the tube. The stenosis begins somewhat below the level of the upper thoracic aperture and reaches about the level of the bifurcation. Below the thoracic section of the trachea is pulled forward and compressed from behind.

As we have already mentioned the information we obtain on the form of incomplete cicatricial strictures of the esophagus by means of lateral irradiation is much more important than our result in the study of the tumor's localization in upright position gives us information only on the upper level of the stenosis without revealing the lower portion of the esophagus. In the event that the stenosis involves but a small portion of the tube it is important to know this. We must also acknowledge both the stenosis and the location but not the shape of the stricture in order that points of passage are still possible. The question must be definitely answered before a surgical procedure is decided upon in the undisturbed. The better we know the condition presented the better will be our result in treatment.

The advantage of examining the patient in the horizontal position as against the upright position are illustrated in Figures 2 and 3. They demonstrate a very strict, of the proximal portions of the esophagus filled in by a white cauter. In Figure 2 examination in upright position the contrast medium is seen to collect at a point above the bifurcation. Below this point there is a thickening of the wall of the cardia. The picture gives no information as to whether the whole

esophagus down to the cardia is stenosed or whether only a small section of the tube is affected. Figure 3 (examination of the same patient in horizontal position) shows that the stricture is only very short that the esophagus widens normally 2 centimeters below this point. The stricture is due to a cicatricial shrinkage which has drawn the anterior wall of the esophagus toward the back. A small passage corresponding to the posterior wall of the tube has been left. We are thus able to learn the length of the stricture, its form and the point at which a passage has been preserved (in this case along the posterior wall). Two centimeters below the upper level of the stenosis there is again a normal breadth to the lumen. The greater width of the esophagus above the stricture is the result of a compensatory widening above the stenosis.

Figure 4 shows how well the X ray examination of the patient in horizontal position can reveal finer stenoses of the esophagus (scar stricture following cauter). Despite the unusual narrowness of the esophagus in this case there is seen a complete filling of the tube not only above but also below the stricture so that we have a complete picture of the cicatricial shrinkage in the esophagus. It is natural that only incomplete stenoses of the esophagus are to be considered for examination in this way. For if the stenosis were complete its form could be definitely cleared up only by a simultaneous filling from above and an esophageal copy from below through a gastrotomy. Sometimes we can also get a general idea as to the length of a scarred stenosis by examining in horizontal position without filling the esophagus. The lateral view of the cicatricial tissue discloses the latter to be less dense than the air filled lumen.

We must also mention the case of a congenital partial esophagus stenosis. The patient was a 15 year old boy who had always suffered from marked swallowing complaints. X ray examination with the patient in upright position (Fig. 5) showed the transient collection of the contrast mass in the esophagus at about the height of the bifurcation. The esophagus was rather markedly dilated above this point but from this level downward the esophagus was seen only as a thin thread. Here again we were unable to decide whether the stricture reached as far as the cardia or not. Figure 6 was made with the patient in the horizontal position (the patient swallowed the paste in this position). It shows that the stenosis is 6 1/2 centimeters long and that below the stricture the esophagus is again normally dilated (at 1). But this examination disclosed still another interesting point and

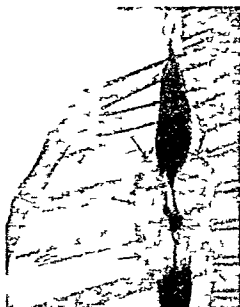


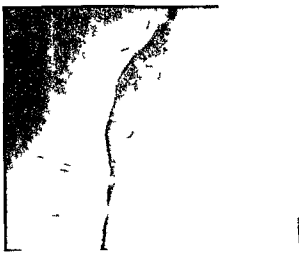
FIG. 1. Esophageal tumor examined with the patient in horizontal position. The patient swallowed the paste in this position. The original photograph is at the right, the sketch at the left. One can see the upper and lower poles of the stricture and the firm adhesion of the tumor. The tumor itself is clearly visible in this projection marked by the arrow. The thoracic portion of the trachea is compressed from behind.

that is the presence of a second stenosis of the esophagus somewhat below the height of the upper border of the sternum (at *B*). This stenosis was hardly visible in the examination in upright position.

X-ray examination of the esophagus in horizontal position is not only valuable for the study of strictures but also in the diagnosis of pathological dilatations especially since bulgings of the esophageal wall as Klobier (1) has already mentioned fill themselves much better with the contrasting paste in horizontal position than in the upright one. The double Figure 1 illustrates these conditions and demonstrates a large *pressure diverticulum* at the height of the cricoid cartilage which as is visible in lateral view takes its origin at the posterior wall of the esophagus in the cervical portion of the latter. The esophagus has been pushed forward by the diverticulum and has also been quite badly compressed from behind.

The X-ray examination in horizontal position is however more important for the diagnosis of

*traction diverticula* than that of *pressure diverticula*. The former are not infrequently revealed only by this method of examination since a more complete filling of the esophagus is attained in the method as a result of the lower passage of the contrasting paste (this was the reason why Palu (2) recommended the examination of patients with traction diverticula in raised pelvis position). We remember a few cases of middle aged persons with swallowing complaints in whom we suspected carcinoma of the esophagus. X-ray examination in horizontal position showed that the cause of the stenosis was an acute angled bulging of the esophageal wall a traction diverticulum. These traction diverticula can sometimes even lead to severe symptoms of stenosis as we were able to observe in a middle aged woman who also had a kyphoscoliosis resulting from a vertebral carie in the earlier years of life. The patient suffered from frequent and increasing complaints in swallowing which finally reduced her to a liquid diet. X-ray examination in upright position



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tion disclosed but one angulation of the wall in which the contrast fluid collected for some time but examination with the patient in horizontal position revealed several distentions on the



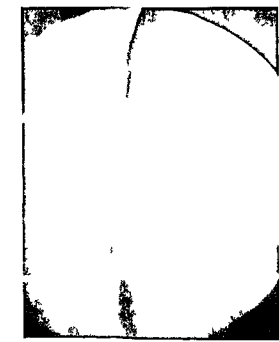
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anterior and posterior walls of the œsophagus (traction diverticula) The patient underwent gastrostomy later when the complaints increased

THE PHARYNX

X ray examination of the pharynx meets with great difficulties as the contrasting fluid swallowed with patient in upright position practically never give a satisfactory cast of the pharynx but rather resolve into drops and crumbs because of the breadth and peculiar form of this formation instead of passing in a solid column as it does in the œsophagus Another deterring circumstance is the fact that the act of swallowing is so quick that a detailed fluoroscopic examination is impossible We refer of course to only the mesopharynx and hypopharynx since the ingested food passes only these sections These portions of the pharynx lie between the soft palate and the pharyngo epiglottic folds on the one side (mesopharynx) and the pharyngo epiglottic folds and the region situated behind the lower border of the cricoid cartilage on the other (hypopharynx) X ray examination of the epipharynx which corresponds to the region of the upper choanæ is even less fruitful In the following paragraphs we wish to describe what is possible in the way of X ray examination of tumors of the mesopharynx and hypopharynx

As we have already mentioned examination in upright position cannot show us much in these portions of the tract Only a very marked hin



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FIG. 5. Congenital stenosis of the esophagus in a 12-year-old boy. Examination was made in standing position. There is transient retardation of the contrast mixture at about the level of the bifurcation. The esophagus is rather dilated above this point and below it the tube is visible only as a narrow thread. The length of the stricture is not recognizable.

drance can be recognized at this point by means of X-rays. Of course even then we will be able to see only the upper border of the stenosis which is not of much value since the laryngologist can learn this much more conveniently and quickly by the use of his mirror. It is much more important to determine the extent of a tumor than the fact of its presence in this case especially since the laryngologist is more or less limited here. In the case of a tumor which projects into the lumen of the pharynx the laryngologist can certainly see the upper pole of the growth but he can tell us nothing of the length of this growth because the prominence of the tumor precludes his looking into the tube. These are precisely the cases which are of such great importance since the operability and the indications for further treatment—operative or conservative—depend upon just such conditions. Even Hajek recommended anterior mediastinotomy in such cases for diagnostic purposes so that one might become oriented on the extent of the tumor. If therefore X-ray examination of these conditions can reveal anything it will solve a real diagnostic problem.

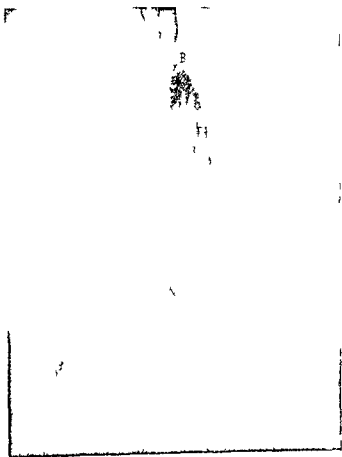


FIG. 6. Congenital stenosis of the esophagus in the same patient as in Figure 5. Examination was made in horizontal position. It is clear that the stenosis is 6 centimeters long and that the esophagus becomes normally dilated above and below the stricture at this point. There is also a second stenosis somewhat below the level of the proximal sternal margin.

In order to reach some definite conclusion we undertook the examination of pharyngeal tumors with the same method we have used in esophageal strictures, i.e. with the patient in horizontal position. The contrasting paste was also given in horizontal position (5). The passage of the paste is slower in the esophagus than in the pharynx. The radiological analysis of the swallowing act is thus easier than it was formerly. As a result of this retardation of the swallowing act the mass of a large bite of the paste fills the mesopharynx and hypopharynx rather well but even more so under pathological conditions in which the impulse to swallow is lowered.

The patient lies on the trochoscopes during the examination on one side the shoulders are pulled backward and the head is supported by sandbags. The backward pull on the shoulders also permits a view of the esophagus which is of importance in that pharyngeal tumors often affect the esophagus. Lateral projection simultaneously shows us a

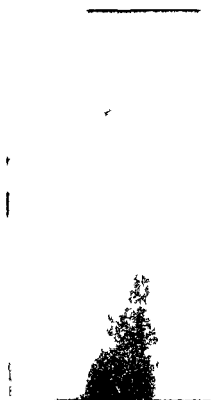


Figure 8 shows the filling in a normal mesopharynx. More than half the swallowed paste has already passed the epiglottis. The picture has a regular and sharply defined contour. Orientation is further simplified by the laryngeal picture which is also visible in the plate. One can see the free portion of the epiglottis, its pedicle and its continuation into the ligamentum thyroepiglotticum from the lower border of which the vocal cord pass to the plainly visible arytenoid cartilages. Two fingerbreadths lower one sees the lower border of the cricoid cartilage, the tracheal aperture simultaneously, the lower margin of the hypopharynx and its transition into the esophagus.



Figure 9 illustrates a pathological case—a tumor of the mesopharynx which protrudes into the hypopharynx and even farther into the cervical portion of the esophagus. As one can easily see the upper pole of the tumor lies just below the level of the hyoid bone. At this point a greater quantity of the contrast fluid has collected like a cupola over the upper pole of the tumor. The tumor affects the posterior and lateral portions of the mesopharynx and hypopharynx and has left but a small passage for the paste at the anterior wall of the pharynx. The picture also reveals the characteristically irregular and fringed border of tumors. The posterior wall of the pharynx is lifted from the spinal column because of a marked swelling of the former, this simultaneously seeming to push the cervical part of the trachea forward. There is no transgression of the tumor to the spinal column—a point which is very important in respect of the operability of such cases. It is nevertheless impossible to operate in this case because of the great extent of the tumor, especially since the neoplasm has already begun to affect the cervical portion of the esophagus. A nor of the esophagus is to be seen only.

clear picture of the larynx and this is an aid in orientation. After fluorocopy a careful plate is made on the X-ray plate can be made separately with the Bucky filter diaphragm a few seconds after the paste has been swallowed. In the latter case it may be necessary to take the plate several times in succession in order to catch the complete filling of the pharynx.

The following illustrations demonstrate what important information such an examination can give. Figure 8 shows the filling in a normal mesopharynx. More than half the swallowed paste has already passed the epiglottis. The picture has a regular and sharply defined contour. Orientation is further simplified by the laryngeal picture which is also visible in the plate. One can see the free portion of the epiglottis, its pedicle and its continuation into the ligamentum thyroepiglotticum from the lower border of which the vocal cord pass to the plainly visible arytenoid cartilages. Two fingerbreadths lower one sees the lower border of the cricoid cartilage, the tracheal aperture simultaneously, the lower margin of the hypopharynx and its transition into the esophagus.

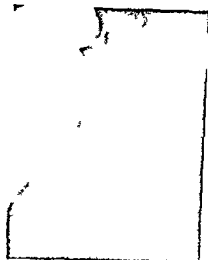
Figure 9 illustrates a pathological case—a tumor of the mesopharynx which protrudes into the hypopharynx and even farther into the cervical portion of the esophagus. As one can easily see the upper pole of the tumor lies just below the level of the hyoid bone. At this point a greater quantity of the contrast fluid has collected like a cupola over the upper pole of the tumor. The tumor affects the posterior and lateral portions of the mesopharynx and hypopharynx and has left but a small passage for the paste at the anterior wall of the pharynx. The picture also reveals the characteristically irregular and fringed border of tumors. The posterior wall of the pharynx is lifted from the spinal column because of a marked swelling of the former, this simultaneously seeming to push the cervical part of the trachea forward. There is no transgression of the tumor to the spinal column—a point which is very important in respect of the operability of such cases. It is nevertheless impossible to operate in this case because of the great extent of the tumor, especially since the neoplasm has already begun to affect the cervical portion of the esophagus. A nor of the esophagus is to be seen only.



Fi 8



Fi 9



Fi 10

Fig 8 Partial cast of a normal mesopharynx  
 Fig 9 Tumor of the mesopharynx which penetrates to the hypopharynx and also extends toward the cervical portion of the esophagus. The upper pole of the tumor lies in the region just below the level of the hyoid bone the

just above the level of the upper thoracic aperture. The lower pole of the tumor is probably to be found at this point.

Figure 10 illustrates a tumor of much smaller size. In this case the upper pole is easily recognized at the level of the arytenoid cartilages the lower pole at the level of the clearly visible calcified plate of the cricoid cartilage. The tumor was removed by Hajek.

Figure 11 shows a tumor of the hypopharynx. The upper and lower poles of the tumor are easily recognizable as are also the length and form of



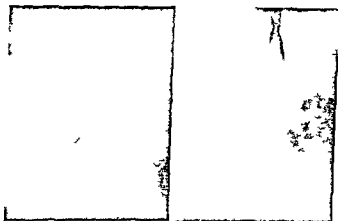
Fi 11 Tumor of the hypopharynx. The upper and lower poles of the tumor are easily recognizable.

the level of the upper thoracic aperture.

Fig 10 Pharyngeal tumor. The upper pole is seen at the level of the arytenoid cartilages the lower pole being at the level of the level of the cricoid cartilage.

the stricture. The tumor is proliferating toward the larynx and forward toward the cervical portion of the trachea. It has already pushed the latter forward and compressed its posterior wall.

If the tumor is large it is often difficult to get the upper and lower poles on the plate at the same time. In such cases we make one picture of the upper pole with a part of the stricture and in a second picture we can then catch the lower pole with the stricture above it during a later phase of the act of swallowing. Such a double picture is shown in Figure 11. The picture on the left shows



Fi 11 A very long pharyngeal tumor. The picture at the left shows the upper pole with a part of the stricture. The picture on the right was taken at a little later phase of the swallow act and shows the lower pole with the stricture above it. The upper pole is at the level of the epiglottis the lower pole the upper terminal margin.



## ENLARGEMENT OF THE PARTURIENT CANAL BY BONE GRAFT

BY IRLD H. ALBEE, M.D., SC.D., F.A.C.S., NEW YORK

**R**EASONING *a priori* from extensive experience in the modification of the contours and dimensions of the skeleton enlargement of the pelvis by bone graft to increase the parturient diameters presents no more difficult a mechanical problem than many which are daily solved in the operating room of the bone plastic surgeon. The feasibility of this procedure has long appealed to the author but as he is not an obstetrician opportunity to work up any considerable series of cases has been lacking.

Two cases are reported in which the author has enlarged the pelvic diameters by placing an inlay graft between the symphyses pubis after forcing them apart  $1\frac{1}{2}$  inches. In both cases the desired result was obtained, the ability to bear children by normal delivery.

## REPORT OF CASES

**CASE 1.** A woman aged 30 years, unable to bear child on account of a contracted pelvis, was referred to me in October 1916 to consider the possibility of enlarging the pelvis by bone graft.

A horizontal incision was made over the symphysis pubis, the pubic ligaments sectioned, and the innominate bones separated at the symphysis. A graft was then taken from the tibia by the same technique used in other bone graft operations and inserted in the hiatus between the innominate bones of the pelvis. The graft was then sutured *in situ* with kangaroo tendons, and the wound closed in the usual way.

The following year the young woman became pregnant and gave birth to a normal healthy infant.

**CASE 2.** F. J., a woman aged 34 years, had a pelvis so small that normal delivery was impossible. She had been pregnant once and the child was delivered at full term by craniotomy. At this time she was told that she could not

have children except by cesarean section because of her contracted pelvis.

Within a year she again became pregnant and 6 months later (March 1917) was referred to me by the late Dr. Samuel Drushkin, a well-known obstetrician to see whether or not it was possible to increase the pelvic outlet. March 9, 1917, she admitted to the L. O. T. graduate Hospital.

The first operation naturally increased the difficulties of operation but it justified the procedure as a successful result was obtained. She delivered a normal child. She has since borne three healthy children by normal delivery. The result obtained in this case is the same as that in Case 1.

I am greatly indebted to the late Dr. Drushkin not only for referring the case but for his encouragement in going forward with the operation during pregnancy.

The author believes that the graft method possesses distinct advantages over symphysiotomy and pubiotomy.

In both cases reported considerable pressure had to be exerted by a specially designed spreader in order to increase appreciably the width of the pelvis and after union the increased width held the bones apart while the patient was in bed. Judging from the author's experience in the two operations the force required to separate the bones any appreciable amount is very great, and after symphysiotomy this force must be withheld from the wedging effect of the head as it is to be ced down ward by the muscle above.

Another advantage of the inlay graft method as compared to symphysiotomy and pubiotomy is that the latter may have to be repeated at each pregnancy in that the hiatus temporarily secured

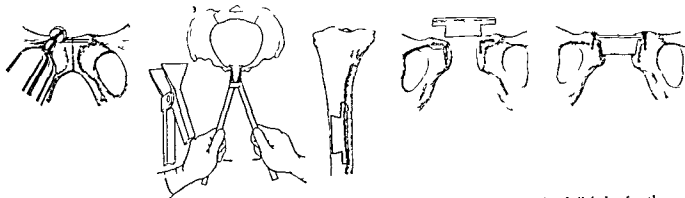


FIG. 1. Author's twin saw grooving the pubic bones on either side of the symphyses.

FIGS. 2 and 3. Spreader used for spreading pelvis after the severance of the symphyses.

FIG. 4. Shape of graft obtained from tibia.

S. B. M. D. F. P. B. L. T.

FIG. 5. Bed of graft. Note the drill holes for the insertion of heavy kangaroo tendon, also the graft ready to be inserted.

FIG. 6. Tibial graft inserted with kangaroo tendon sutures in place.

No. 49



## TECHNIQUE

during labor immediately disappears. The author has repeatedly confirmed this by X-ray study of cases immediately and remotely following operation. On the other hand the enlargement of the pelvic ring by bone graft is a permanent enlargement. The only alternative is a caesarean section.

The iliac graft is apparently the only method which effects permanent enlargement of pelvis too small for normal delivery. It is particularly applicable to the primiparous type.

The technique is shown in Figures 1 to 6. The end of the graft are mortised into the symphysis by the author's only technique used in other bone grafting operations. In the enlarging of the pelvis the strength of the graft is exceedingly important. Great care must be taken that it is sufficiently strong to withstand the pressure of the bones as they attempt to get back to their former position.

STIFFENING FIBROUS TENDONAGINITIS OVER RADIAL STYLOID (DL. OUVERAINE<sup>1</sup>)

B. CHESTER C. SCHNITZER, M.D., MILWAUKEE, WIS.

FOR several years my attention has been directed to an interesting condition at the wrist concerning which I could find no enlightenment in American literature. The relative frequency of the condition and the striking similarity of all cases in their symptoms and physical findings made it seem evident that this was a definite clinical entity worthy of careful study and analysis.

The patients with this condition invariably complain of severe pain at the wrist, more or less definitely localized in the region of the radial styloid and radiating into the hand and up the forearm. They give a history of a gradually developing pain at the site of the radial styloid usually without any precipitating trauma. This pain becomes so severe in the course of weeks or months that complete disability of the wrist ensues. Occasionally the pain assumes a neuralgic character and is very severe at night. Abduction and extension of the thumb are accompanied by severe pain and pressure over the radial styloid is exquisitely tender. Intracutaneously all of the patients that have come under my care have been seen previously by one or more physicians who have variously diagnosed the condition as rheumatism, neuritis, ulnar neuritis, usually prescribing heat, salves, electricity, and rest. Despite these measures the symptoms have become increasingly severe finally incapacitating the wrist for further use.

Physical examination reveals definite swelling in the region of the radial styloid (Fig. 1) extremely tender to pressure. Abduction and extension of the thumb are very painful in many

instances the patients being unable to perform this motion at all. Even gripping and ulnar and dorsiflexion produce pain over the involved region. Frequently a gristle-like thickening can be felt under the skin while at times the periosteum of the underlying radius seems thickened. There is never any local heat, redness, infiltration or crepitation in the tendon sheath on motion.

It is interesting to note that all the pathology occurs at the point where the abductor pollicis longus and extensor pollicis brevis tendons pass under the superficial dorsal carpal ligament through the scaphoid canal immediately overlying the radius. Because of the fact that these muscles arise on the dorsal surface of the forearm as extensors and curve around the distal end of the radius to become abductors of the thumb (Fig. 2) they are exposed to increased friction at this site. Likewise in consequence of their superficial position between the bone and skin they become exposed to more frequent trauma than other tendons.

This condition was first described in 1893 by de Ouverain of Basle, Switzerland, who reported 5 cases in the *Correspondenz Blatt fuer schweizer Aerzte*. He saw his first case under Professor Kocher at the Bern Klinik in 1893. Subsequent to de Ouverain's first paper a considerable number of German and French clinicians reported additional cases investigating the condition quite exhaustively. The most comprehensive study was made by Alfons Eschle of Basle in 1924 who tabulated the 110 cases previously reported in the literature and added 19 more which had come under his own observation.



FIG. 1. Photograph of normal and involved wrists showing swelling over radial styloid in the latter.

Although I have personally seen and treated between 25 and 30 cases in clinical and private practice I have been able to collect the records of only 15 of these. This makes a grand total of 144 cases. In 133 of these where the sex was reported 119 were women and 14 men. Out of 89 where the side was noted 47 were right 44 left and 4 bilateral. These patients ranged in age from 15 to 75 years the majority however being between 35 and 55. Housewives and maids constituted the largest vocational group there being 81 with this classification. Further there were 7 farm women 4 factory workers 3 nurses 2 pianists 1 milliner 1 plasterer 1 hairdresser 1 laborer and 1 architect.

Although the exact etiology of this condition is not clear there seems to be more or less agreement among the various authors that *excessively monotonous* use of the involved tendons is the most commonly evident cause. The incidence of the disease practically exclusively among workers who use their thumbs a great deal seems to substantiate this view. In some instances a single direct blow to the exposed tendon sheath has been the sole etiological factor while in other cases injury followed by excessive use of the thumb has been responsible. A few authors have noted a rheumatic predisposition in some of their cases but this is by no means constant. Lues and tuberculosis have been definitely ruled out as bearing no relationship to this condition. The primary cause then as far as can be determined is a mechanical rubbing of the abductor pollicis longus and extensor pollicis brevis tendons over the rounded distal end of the radius. This becomes quantitatively increased by increased force or frequency and produces an oedema of the tendon sheath and results in a vicious circle increasing the friction and causing the lumen of the tendon sheath to become narrowed. Trauma qualita-

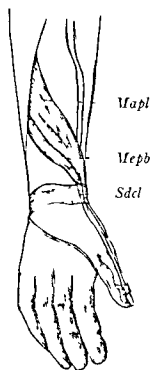


FIG. 2. Sketch showing origin and insertion of abductor pollicis longus and extensor pollicis brevis. Note how tendon curve around radial styloid in common tendon sheath under superficial dorsal carpal ligament. *Apl* abductor pollicis longus muscle. *Epb* extensor pollicis brevis muscle. *Sdc* superficial dorsal carpal ligament.

tively influences the irritation by increasing the oedema or changing the underlying bone.

According to all the authors who have previously written upon this subject X-ray examination has consistently failed to reveal any change in the underlying bone. My own cases have corroborated this observation with one or two exceptions. Figure 3, a roentgenogram of the normal and involved wrists reveals some deposition of lime salts over the radius at the site of the fibrocartilaginous disc of the diseased tendon sheath. This suggests a probable extension to the periosteum of the bone in the nature of a proliferative reaction such as one might expect to see following trauma or inflammation.

Figure 4 shows a similar change but to a lesser extent in another case. These bone changes might be ascribed to the extension of irritation to the periosteum or may be only structural variations in normal bones.

No relationship has been established between this disease and syphilis. All the blood Wassermann tests in my own cases have been negative as is true of all the cases previously reported in the literature. Likewise no evidence of tuberculosis has been noted in these cases. Although tuber-



Fig. 1 (left) Nodular thickening of the palmar fascia. Fig. 2 (middle) Nodular thickening of the palmar fascia. Fig. 3 (right) Nodular thickening of the palmar fascia.

contracture of the hand is a well known disease. The disease is characterized by the development of nodules and cords in the palmar fascia, which leads to the contracture of the hand. The disease is not in any way related to the course of the tuberculous disease.

The pathology of this condition has been studied very carefully by Koster, de Quervain, Kessler, Vischer, Hauck, Nussbaum, Horcken, and Eschle. It was Koster who first named the condition "stenosis fibrosa tendovaginitis" because of the fibrous thickening which he noted in the middle layers of the tendon sheath. He looked upon the condition as a passive function hypertrophy and placed it in the same class with snapping finger (*doigt à essouffé*). According to Nussbaum the normal tendon sheath is composed of 5 layers. The inner layer is the parietal part of the same tissue which covers the tendons (visceral layer) and is composed of strata of flat or cubical cells with spindle shaped or round nuclei. This layer frequently has finger like processes and contains fine lymph vessels without muscle walls. The second layer is composed of loose connective tissue containing nerves and blood vessels. Then follow thin firm layers of connective tissue, the inner layer with filers

running parallel to the outer across the blood supply, the latter being the wider of the two. The fifth and last layer is composed of loose connective tissue with nerves and blood vessels. Whereas grossly the common tendon sheath of the abductor pollicis longus and extensor pollicis brevis tendons is normally a thin colorless transparent membrane in this disease it is thickened and transparent and cuts like gristle. The canal is narrowed so that in some cases it is difficult to pass a thin probe through it. When cut the sheath looks milk white, the inner surface being yellow to red in color here and there being velvet like. While at times the sheath itself may be thickened to 4 times its normal depth the tendons themselves show no changes. Occasionally the

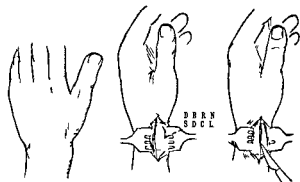


Fig. 4 (left) Sketch of the hand showing the thickening of the palmar fascia. Fig. 5 (middle) Sketch of the hand showing the thickening of the palmar fascia. Fig. 6 (right) Sketch of the hand showing the thickening of the palmar fascia.



Fig. 7 (left) Photograph of the hand showing the thickening of the palmar fascia. Fig. 8 (right) Photograph of the hand showing the thickening of the palmar fascia.

TABLE I—SYNOPSIS OF FIFTEEN CASES OF DULPAIN'S DISEASE PERSONALLY EXAMINED

No	Name	Age	Occupation	Side	Duration	Cause	Treatment		Result
1	A F	50	Milliner	Left	1 month	Arthritis	6 to 8 weeks	Further R refused	Unimproved
2	I B	30	Laborer	Right	5 months	Excessive use	6 to 8 weeks Operation		Unimproved Cured
3	C B	48	Architect	Right	weeks	Excessive use	9 to 10 weeks	Further R refused	Unimproved
4	M R	15	Student	Left	1 year	Bad all strain	6 to 8 weeks		Cured
5	E B	21	Dressmaker	Right	1 month	Severe strain	6 to 8 weeks		Cured
6	C G	16	Student		1 month	Using crutch	None		
7	K F	33	Housewife	Right	6 months	Excessive use	6 to 8 weeks		Cured
8	S T	50	Housewife	Left			6 to 8 weeks		Cured
9	A J	25	Housewife	Left	3 weeks		6 to 8 weeks		Cured
10	C W	47	Housewife	Right		Arthritis	6 to 8 weeks		Cured
11	F D	40	Nurse	Right	weeks	Excessive use	9 to 10 weeks		Cured
12	C P	37	Nurse	Right	months	Excessive use	6 to 8 weeks		Cured
13	A B	40	Housewife	Right	months	Excessive use	6 to 8 weeks Operation		Unimproved Cured
14	C F	45	Nurse	Left	5 months	Inflamed and moist	6 to 8 weeks	Further R refused	Unimproved
15	J M	53	Housewife	Left	3 months	Fall on wrist	Untreated		

tendons may be adherent to each other with a thin fibrous band. Three of Keppler's cases showed firm adhesions between the tendons and the sheath. All the authors seem to agree that the tendon sheath is too narrow for the tendons.

Histologically most of the cases fall into one of two groups according to Nussbaum. Group 1 in which the majority of them lie shows a connective tissue proliferation in the sheath 3 fold to 4 fold. There is no fixed direction of the fibers and the endothelium and its substratum are frequently absent. In the second group the blood vessels and nerves loosely held in the outer layers of the sheath are surrounded by round celled infiltration. Many sections in this region show small irregular necrotic areas. On the inner side of the sheath the blood vessels are increased. The occlusion of the lumen of the sheath is often directly produced by necrotic masses. This histological evidence would point to the fact that we are here dealing with a reaction to trauma or excess use which is not inflammatory. Some factor is responsible for the stimulation of the fibrous tissue growth in the connective tissue layers of the tendon sheath.

In the treatment of this condition a wide field of therapeutic aids has been tested practically all of them to no avail except prolonged immobilization and surgery. Heat, electricity, plasters, rest, massage, internal medicaments, etc. have been of no avail. Practically all of the European writers who have described this condition are agreed that conservative measures do not yield encouraging results. In my own practice I have employed a plaster of Paris cast to the thumb and wrist with the thumb in full extension and abduction (Figs 5 and 6). Such cast when allowed to remain on from 4 to 6 weeks produced a complete remission of symptoms in 7 out of 10 cases. Immobilization must be absolute and sufficiently prolonged to permit complete resolution of the pathological changes which have taken place in the sheath. In those cases where the fibrous stenosis has become too advanced to respond to immobilization alone surgery has provided a simple and effective solution to the disability. The operation proposed by de Quervain and successfully used by a number of European surgeons is as follows: Under a local anæsthetic a linear incision about  $1\frac{1}{2}$  inches long is made over

the distal end of the radius through the skin and subcutaneous tissue. Overlying the superficial dorsal carpal ligament is a small branch of the radial nerve which should be retracted. A cut is made through the carpal ligament immediately over the tendon sheath and then the thickened sheath is split for a distance of about 1 inch. The skin is closed and the wound dressed without a cast. Figures 7, 8 and 9 show the steps of the operation. Active motion can be undertaken within a few days and full restoration of function may be anticipated within a few weeks. Of 66 cases collected by Lischke which were treated surgically in this manner 65 were cured and 1 improved. I have resorted to surgical division of the common tendon sheath in cases both of which were cured.

Table I gives a summary of the 15 cases from my own records and indicates the treatment rendered and results obtained along with other pertinent data. It will be seen from a cursory examination of this that the correct employment of the plaster cast has afforded cures in 70 per cent of the cases thus treated and that this treatment is to be recommended in the cases seen fairly early.

To summarize briefly, we are here dealing with a clinical entity not previously described in American literature or textbooks known as de Quervain disease. This is a passive function hypertrichy of the fibrous layers of the common sheath of the abductor pollicis longus and extensor pollicis brevis tendons causing a stenosis of the sheath over the radial styloid and impairment of function of the thumb. The pain over the radial styloid may be so severe as to produce complete disability at the wrist. The condition is a chronic one and responds only to complete immobilization

of the thumb and wrist in a cast from 4 to 6 weeks or in late cases surgical splitting of the stenosed tendon sheath.

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## SUBPERITONEAL CHOLECYSTECTOMY<sup>1</sup>

BY LESTER R WHITAKER M D ROCHESTER NEW YORK

Nat. Res. Arch. C. J. Flow. d. P. f. I. b. I. M. t.

ANY abdominal operation should attain its object with as little trauma of the viscera as possible to the end that shock may be kept at a minimum postoperative discomfort reduced convalescence shortened and adhesions prevented. Exposure of the cystic duct in the usual operation for cholecystectomy necessitate a great deal of gauze packing with pressure and traction on the viscera which renders the operation more dangerous and more likely to be followed by complications than is perhaps necessary.

To obviate these disadvantages the following method has been developed thus far applied only experimentally to dogs though for anatomical reasons it should not be more difficult in selected patients.

The principle of the operation is removal of the gall bladder through a small abdominal incision by subperitoneal dissection from above downward to the cystic duct. This depends upon the anatomical fact that the peritoneal covering is very loosely attached to the gall bladder. I have frequently noted the empty contracted gall bladder of an animal to be rolled up beneath its serosa which is attached along the sides of the gall bladder fossa of the liver. This relation has been observed also in patients at necropsy following manual expression of the vesicular content. The serosa thus acts as a covering or cloth under which the viscus may contract or move about. Its laxity is of extreme importance in the operation to be described not only insuring ease of separation but allowing sufficient retraction of the membrane away from the gall bladder to obtain exposure even as far down as the cystic duct.

## TECHNIQUE

An incision is made as nearly over the gall bladder as possible only large enough to allow delivery of the fundus. Small retractors on opposite sides lift the abdominal wall upward and outward and if the gall bladder is not immediately visible an exploratory lamp is inserted with

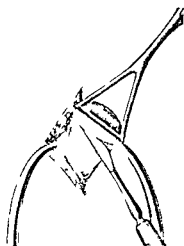
A curved blade attached to one side which acts as a visceral retractor. Upon sight the fundus of the gall bladder is grasped with a triangular tipped Collins clamp and pulled into the wound (Fig. 1). The two retractors are then replaced by a small self retaining retractor. A circular incision is made with a very sharp knife through the serosa near the tip of the vesicle (Fig. 2). By means of fine forceps and a rather sharp round tipped suction dissector<sup>3</sup> the serosa is freed from the gall bladder for 1 or 2 centimeters thus forming a peritoneal cuff (Fig. 3). Silk traction sutures applied radially to the edge of the cuff are secured to the drape, or held by assistants thus opening the cuff. Traction on the gall bladder is maintained. By the aid of a headlight and a special wire retractor and using either the suction dissector or gauze tips the dissection is carried down toward the cystic duct (Fig. 4). It is noted the gall bladder can be opened and partially emptied of its contents in order to facilitate dissection.

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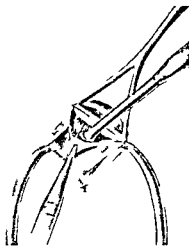
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Fig. 1. Shows position and relative size of incision for subumbilical cholecystectomy in a dog.

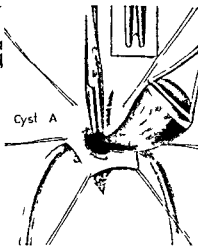
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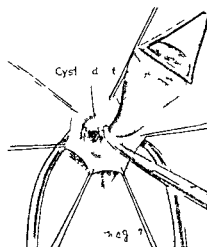


Fig 5

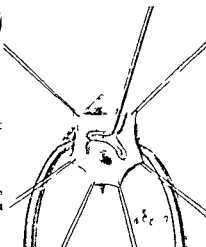


Fig 6

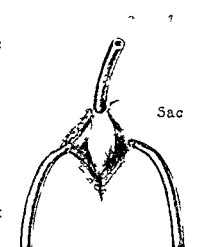


Fig 7

I 5 G l l d d h l d p b C l l m p l f  
t t t t p l l f m l  
th gh t l p t m Th d p h b m t t d  
so t t t h f l l m y b l l  
I B p t f th p t m th  
f p d t d t  
Fig 4 K d l t t t p t l l  
S l l p b k p l d y t t v h h f th

p r p e f l l t t the a t t h a f m l lv  
th t t p p  
I g 5 C y t d c t d e t d f l m p e d d t d  
I g 6 Sh c f o m l h g l l b l l h  
m d b e q h d p b y p l t t Th  
t m p o f t h c y t d t h t t e d t t h l t t h  
b t t m  
I g 7 S c l l p l b e t r u b b d g t b

Ordinarily however the process is easier with a moderately full vesicle.

When resistant strands of fibrous tissue interfere with the stripping process they are cut with scissors close to the gall bladder in order to avoid button-holing the peritoneal sleeve or damaging the liver. If the strand is large a Cushing silver clip should previously be applied for some of them will contain vessels running from the gall bladder to the peritoneum. Surprisingly little bleeding is encountered however since most of

the vessel remain on the gall bladder. Should any be torn off the bleeding points on the vesicle can be stopped by a touch with the electrocoagulator or by a silver clip. The suction dissector keeps the field clear of blood oozing from the small vessels. Near the region of the cystic duct all large strands of fibrous tissue should be doubly silver clipped before division since one of them will contain the cystic artery (Fig 4). If the artery by chance breaks loose there is little danger since all the bleeding is within the peritoneal



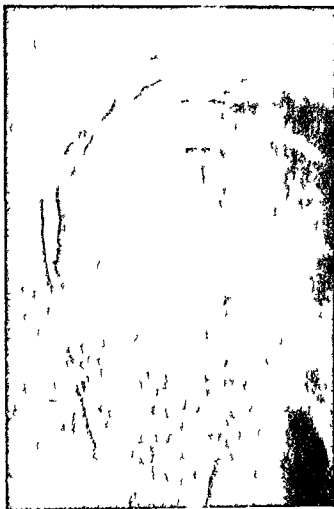
FIG. 8 Sutured wound with drainage tube

sleeve. The blood can be removed with a sucker of adequate size and time taken to secure the vessel. If this is not possible a gauze packing kept dry with suction can be applied until coagulation occurs. In some of my experimental operations in which the cystic artery broke loose and was not secured, not over 50 cubic centimeters of blood was lost.

After the cystic artery is cut, the cystic duct is easily dissected out under traction. If the duct breaks off during this process, no damage ensues, since any leakage of bile will be carried off through the peritoneal sleeve. When the duct is freed, it is clamped as low as possible, tied, and the vesicle removed (Fig. 5). Upon release, the stump retracts into the recess under the peritoneum from which the duct had been withdrawn (Fig. 6).

Should there be a question of common bile duct obstruction in patients, however (though this should have been ruled out by careful preoperative examination), iodized oil can be injected into the stump of the cystic duct left rather long and roentgenograms of the ducts made (Fig. 9). If it should be expedient to test the patency of the ducts before this stage is reached, the gall bladder can be opened, emptied of its contents and filled with iodized oil, then by gentle pressure the oil can be forced down the ducts. If unforeseen obstruction is noted, it can be dealt with in the usual manner if the incision is enlarged.

Finally, after subperitoneal removal of the gall bladder, a small rubber tube with side holes is placed in the peritoneal sleeve and brought to the outside, the sleeve being collapsed about the tube and lightly tied at the point of contact with the abdominal wall (Fig. 7). Thus the tube is completely peritonealized and any leakage of bile or blood into the peritoneal cavity precluded.



It is important to note that the operation is performed upon 16 dogs. Fourteen made perfect recoveries, apparently showing very few effects of any kind from the procedure. Two died after the operation, one of peritonitis and bile leakage, in which the cystic duct had been clamped and electrically coagulated, no drainage of the peritoneal sac being employed; the other also not drained, died of leakage of blood and bile into the peritoneal cavity through an accidental opening in the peritoneal sac. These two poor results emphasize the necessity for stopping hemorrhage before closing the wound and for subperitoneal drainage for 1 to 2 days. The 14 other dogs at necropsy showed only a few omental adhesions at the operative site.

#### THE QUESTION OF CLINICAL APPLICATION

The first requisite for such a procedure as has been described would be a definite diagnosis. It must be determined with reasonable certainty



that the gall bladder and not the stomach duodenum or pancreas is the organ diseased. This implies extremely careful study of the case and the application of all necessary tests including roentgerological studies of the gastro intestinal tract and frequent determinations of the icterus index over a period of one or more weeks.

In the diagnosis of gall bladder disease the history is of great significance and the ruling out of disease of other organs by appropriate tests is essential but cholecystography is the method *par excellence*. If a shadow of the gall bladder be obtained the condition of the viscus can be accurately predicted in almost every instance. A shadow definitely mottled in

every instance. A shadow definitely mottled in successive films indicates stones while contraction after feeding indicates an active musculature without marked sclerosis. This combination frequently occurs. Furthermore the very production of a shadow implies that the vesicle is active enough to empty and allow refilling, indicating a non sclerotic wall and a sero-a which will readily strip away. Such a gall bladder presents the ideal case for subperitoneal cholecystectomy. The method would probably have been applicable to all the cases reported in my article on the diagnosis of gall bladder disease.

If no shadow of the gall bladder be obtained by the intravenous method of cholecystography

the gall bladder is almost surely diseased perhaps severely enough to preclude subperitoneal cholecystectomy but in many cases the failure of shadow formation is due to partial blockage of the cystic duct with stones or a gall bladder so full of stones that an insufficient quantity of the radio opaque material can enter yet in either of these cases the wall may not be sclerotic enough to prevent stripping of the serosa

To determine whether or not this be true a small incision can be made as nearly over the fundus of the gall bladder as may be after very careful percussion and palpation with the patient under ether and the condition investigated by an exploratory lamp. If the gall bladder be found fibrotic or bound down by a mass of adhesions of course the case is unfavorable for subperitoneal cholecystectomy and the regular operation should be done. The presence of a few adhesions need not necessarily contra indicate a subperitoneal cholecystectomy. The gall bladder may be pulled up if possible and the adhesions ignored or they may be previously dissected away. I have observed that in many excised gall bladders which had had adhesions the serosa would still strip readily. Subperitoneal cholecystectomy cannot be done if the gall bladder is too friable to allow moderate traction.

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A PRACTICAL CONSIDERATION OF THE DAMAGED PELVIC FLOOR WITH A TECHNIQUE FOR ITS SECONDARY RECONSTRUCTION<sup>1</sup>BY BYRON H. COLLINS, M.D., F.A.C.S., NEW YORK  
ATLAS, W. H. J. I.

THE operations which are commonly employed in the secondary reconstruction of the lacerated or relaxed pelvic floor are of two distinct types. The less radical type of operation which consists of a superficial denudation of vaginal mucous membrane, an incision of the denuded portion of the rectovaginal septum, and a reconstruction of the perineum is still used by a considerable number of both gynecologists and general surgeons. The majority of operators, however, have adopted a more radical type of procedure in which some form of flap splitting of the rectovaginal septum is followed by a direct union of the anterior portions of the levator ani muscles between the vagina and rectum and by a reconstruction of the septum and perineum.

During the past decade many operations of both types have been performed according to the accepted technique by members of the staff of the Woman's Hospital, and in approximately 75 per cent of the cases the end results have been carefully observed for periods of time ranging from 1 to 3 years. The follow-up findings have thrown much light upon the relative merits of the two generally accepted methods of reconstructing the damaged pelvic floor and have clearly revealed certain objectionable features in the end results of both types of operation.

The objections to all operations in which denudations and incisions of redundant tissue are employed are (1) the impossibility of a restoration of the levator ani muscle to normal anatomical position and function by such procedures, and (2) the unjustifiable incidence of recurrent rectocele which follows their application.

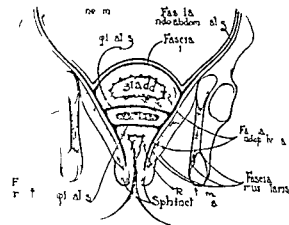
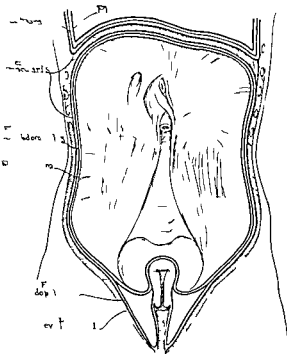
In the restoration of the retracted levator ani to its normal position and function it is essential to expose its fascial covering and the superior layer of the urogenital trigone to which its fascia is attached. To do so necessitates flap splitting of the rectovaginal septum, and a type of flap splitting in which the flap includes all layers of the septum from the vaginal mucosa to the rectal musculature. An examination of the accompanying anatomical charts convinces one of the impossibility of such an exposure by any form of mucous membrane denudation.

The high incidence of recurrent rectocele which follows the type of operation under consideration

is satisfactorily explained by the fact that in this type of procedure the fundamental principles which underlie a successful surgical correction of a hernia—and a rectocele is a hernia—have not been observed. In the surgical correction of any hernia it is of fundamental importance to incise all layers of the hernial sac which in a rectocele is the herniated portion of the rectovaginal septum, and to remove from the sac its content, the abnormally situated and adherent rectum in the case of the rectocele. The remainder of the correction consists in the removal of the hernial sac and the closure of the hernial opening through the use of available muscle and fascia. It is obvious that such principles are not observed in the superficial type of operation.

The more radical operation in which flap splitting and direct levator myorrhaphy are employed, though productive of generally good results in the immediate cellular reaction in most instances to restore the levator ani to normal function. As levator myorrhaphy is usually performed varying amount of the tissue is severed and immobilized anteriorly, the muscle at the incision site are united between the vagina and rectum with a similar bundle of fibers in the muscle of the opposite side. Sutures which have been placed about the muscle bundles above the perineum are tied under a tension sufficient to hold them together until union occurs. Despite the care with which such sutures are tightened, it is extremely difficult to avoid a pressure atrophy of the included muscle fibers with the result that a more or less crescentic rigid and functionless band of scar tissue forms at the site of the junction of the muscle bundles. It is a well recognized fact that such bands of scar tissue cause dyspareunia and dystocia and are responsible for an impairment or complete loss of function in the most important fibers of the levator muscles.

In an effort to avoid the objectionable sequelae of the two conventional methods of reconstructing the injured pelvic floor the operation herein described was devised. It has been under trial by several members of the staff of the Woman's Hospital for the past 4 years and has gained a confidence which seems to warrant a preliminary report at this time. It has been based upon a recognition of the following facts concerning the normal anat-



segment III ( ) in commentum upon this phic ftl ul t s v There is usually to be t unl t liv l n line across the muscle on a level with th juncti n f the superior ramu of the pulis with the ilium anl separatin thos filer whi h are in r t l into the coccyx and the poster r p r t n f the fibrous raphe from thos which pas t the interi r part of the rhye and the rectum Each f the portions so separated is supplied by a separate nerve and th combined with the results f c mparative anatomy shows that the poster r p r t n f the levator really a muscle quite distinct fr m the anterior portion It has t n termed the musculus iliococcygeus Furthermore it seems probable that the anterior portion is composed of two morphologically distinct muscles one of which arises from the pubi and anterior part of the white line and is inserted into the median fibrous raphe whence it is termed the pubococcygeus while the other situated beneath i e superficial to the pubococcygeus consists of those filers which arise from the pubi and are inserted into the rectum and i termed the musculus puborectalis

There has been considerable controversy concerning the presence or absence of filers of the levator ani in the perineal body between the rectum and the vagina. Dissections by Martin (6) and others have proved conclusively that there are filers of the puborectalis the fibers of Muska which pass between the rectum and vagina to insert into the perineal body.

Of the three portions of the levator ani the two more anterior portions the pubococcygeus and the py are from the viewpoint of the gynec obstetrician the most important segment actually and functionally.

omy and function of the pelvic floor and the changes which occur as a result of injury at the time of parturition

## NORMAL ANATOMY OF THE PELVIC FLOOR

The pelvic floor or pelvic diaphragm is formed by the levator ani muscles, the coccygeus muscles and the fascia which surround them. The diaphragm thus formed almost closes the pelvic outlet and separates the pelvic cavity from the perineum which completes the closure.

The levator ani muscle, the larger and more important of the two muscles which form the muscular portion of the pelvic diaphragm, arises from the posterior surface of the os pubis, the white line (arcus tendineus muscoli levatoris ani) and the spine of the ischium. From this broad origin the fibers run downward, backward and inward to become attached to the sides and tip of the coccyx, to the fibrous raphe (ligamentum anococcygeum) which extends from the tip of the coccyx to the anus, and to the sides of the rectum. A few fibers, the fibers of Muska, from the most anterior portion of the muscle pass between the vagina and rectum to be inserted into the perineal body.

Though the levator ani is usually regarded as one muscle, it is composed of three separate flat

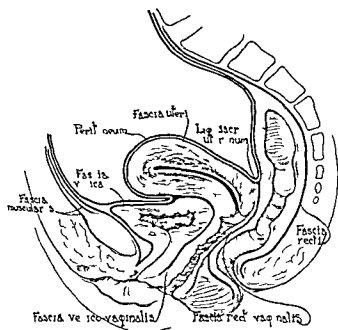


FIG. 3. Illustration in sagittal section the distribution of the fascia endopelvis about the bladder, the vagina, and the rectum.

(9) has said: "Their lines of origin extend for 17 inches on either side of the posterior surface of the pubic symphysis, thus equalling in width the average sternomastoid; they are twice as thick as the diaphragm, weigh one-fourth as much as the external oblique, altogether presenting a muscular support exceeding that guarding the inguinal ring."

These pubic segments course almost horizontally backward and inward along the lateral vaginal wall. They converge rapidly toward those of the opposite side to become inserted into the perineal body, the rectal walls, and ano-coccygeal tendon, encircling the vagina and rectum in distinct loops.

Their median borders, which are plainly palpable through the lateral vaginal walls, a half inch or less behind the plane of the hymen, form a V-shaped interspace which embraces the introitus under the pubic arch, and is termed the levator cleft (hiatus genitalis). In this cleft are the urethra, vagina, and rectum.

The *coccygeus muscle*, the flat fan-shaped muscle which completes the muscular pelvic diaphragm posteriorly, arises from the spine of the ischium and is inserted into the sides of the sacrum and coccyx. It is of no practical importance to the gynecologist.

The *pelvic fascia*, the fascia of the pelvic diaphragm, is a continuation of the iliac fascia. It descends over the anterior surface of the pyriform muscle, the upper portion of the obturator internus, and the superior surface of the levator ani, and

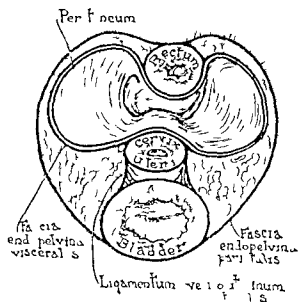


FIG. 4. Illustration in cross section made at a level of the corpus uteri showing the distribution of the fascia endopelvis.

coccygeus muscles. This flat fan-shaped fascia, which covers the upper part of the pelvic diaphragm, is termed the muscular part of the pelvic diaphragm. It is continuous superiorly

with the iliac fascia, and the iliac fascia of the pelvic diaphragm, which continues down to the coccyx, is continuous with the lower portion of the iliac fascia. The fascia of the obturator foramen is continuous with the fascia of the iliac foramen.

Along the lateral surface of the iliac fascia of the pelvic diaphragm, the iliac fascia

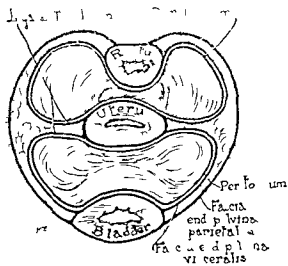
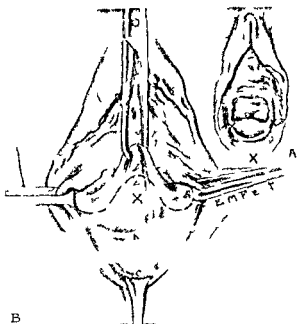


FIG. 5. Illustration in cross section made at a level of the corpus uteri showing the distribution of the fascia endopelvis.



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there is a curved thickening in the pelvic fascia which extends from the posterior surface of the symphysis pubis to the spine of the ischium or in some instances to the iliopectineal line. This thickening is termed the white line (arcus tenineus musculi levatoris ani) and from it a large portion of the levator ani takes its origin.

From the white line a thin layer of fascia extends inferiorly over the inferior surface of the pelvic diaphragm and is termed the inferior fascia of the pelvic diaphragm (fascia diaphragmatis pelvis inferior).

The superior and inferior fasciae of the pelvic diaphragm form a compartment for the levator ani and enclose it as it fuses along the anterior border of the levator ani with the superior layer of the uracut ligament (triangular ligament). Inferiorly and medially each of the two layers of the levator ani and the pelvic diaphragm fuses in the sagittal plane with a corresponding layer from the opposite side.

In the above description of the pelvic fascia it is apparent that the term pelvic fascia applies only to the fascial coverings of the pelvic muscles.

**Fascia of the pelvis.** As the pelvic muscles are surrounded by layers of the pelvic fascia so the pelvic viscera are surrounded by sheaths of a thin fascia which accords with the descriptions in standard textbooks in that they originate from a

common curved thickening in the superior fascia of the pelvic diaphragm. This arcuate thickening extends from a point a little to the outer side of and slightly above the lower border of the symphysis pubis to the spine of the ischium and is termed the arcus tendineus of the pelvic fascia. Upon the origin of the visceral layers of the pelvic fascia all textbooks agree. On the contrary Halban (4) who has made a careful and convincing study of the fasciae of the pelvis disagrees not only with the descriptions in standard works on anatomy but also with those in the writings of gynecologists.

Halban describes a layer of thin fascia which is situated between the parietal peritoneum and the fascial coverings of the abdominal muscles and terms it the fascia endoabdominalis (Fig. 1). This fascia extends over the entire abdominal parietes and thoracic diaphragm, sends layers to the abdominal viscera and descends into the pelvis to become the fascia endopelvina (Fig. 2) which is composed of a parietal and visceral portion. Halban contends that the fascia endopelvina is a distinct fascia which is not a part of the fascial sheaths of the pelvic muscles. He emphasizes the fact that the parietal portion of the fascia endopelvina though lying upon and attached to the muscle fascia by connective tissue is distinctly separable from it. It is apparent therefore that he recognizes two distinct fasciae in the pelvis the muscle fascia and the fascia endopelvina the distribution of which is clearly illustrated in the accompanying diagrams (Fig. 1, 2, 3, 4 and 5).

To the various layers of the visceral portion of the fascia endopelvina are given definite names which are indicative of their situation. It is important to bear in mind that they are all parts of the same fascia and all fuse laterally.

In a consideration of cystocele and rectocele the layers of the fascia endopelvina which are of greatest importance are the vesicovaginal layer which lies between the bladder and the vagina and the rectovaginal layer which lies between the rectum and the vagina. It is to be noted that these layers fuse at the sides of the vagina to form a perivaginal sheath which is situated just without the vaginal musculature. Halban has given to this sheath the term perivagina fibrosa.

Authors who have written upon the subjects of cystocele and rectocele have frequently used terms which are vague and misleading among them the terms fascia propria of the vagina and rectum. The terms are poor ones in that they lead one to believe that there are individual fasciae about the vagina and rectum without indicating their origins or situations. Halban's terms

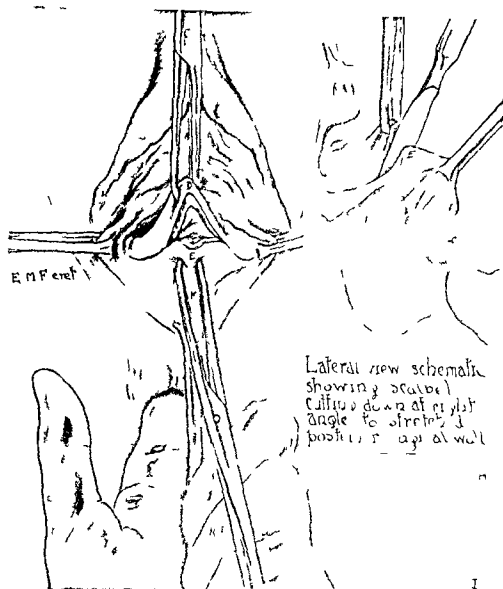


Fig. Illustrating the method of making the all layers of the septum and lead into the rectum.

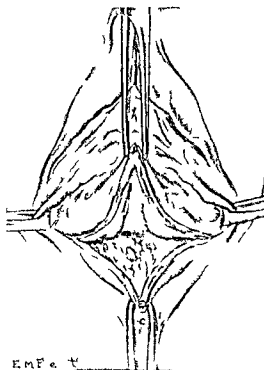
are definite and descriptive and should be universally adopted.

**The perineum.** The term perineum is applied to that lozenge shaped region at the pelvic outlet which is bounded by the symphysis pubis the coccyx the greater sacrosacral ligaments the ischial tuberosities and rami and the pubic rami. A straight line drawn between the anterior borders of the ischial tuberosities divides the region into an anterior urogenital triangle and a posterior rectal triangle.

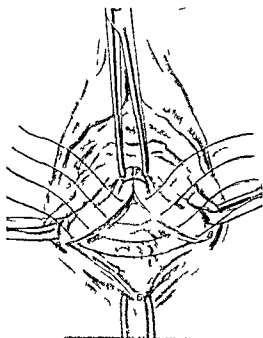
The urogenital triangle—to the gynecologist and obstetrician the more important of the two perineal triangles—is bounded by the symphysis pubis anteriorly by the rami of the pubes and ischia laterally and by the posterior margins of both layers of the urogenital trigone posteriorly

where they become continuous with each other and with the fascia of Colles.

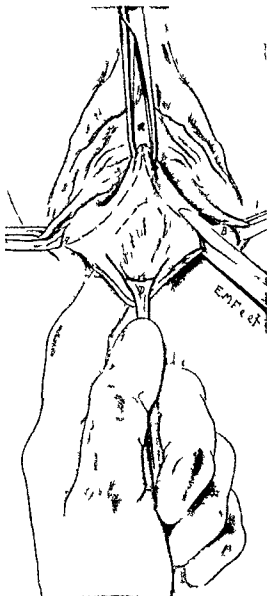
Extending across the urogenital triangle is a fascial plane the urogenital trigone (triangular ligament) which forms a complete diaphragm over the anterior half of the perineum except the urethral opening and the vaginal cleft. This important fascial structure is formed by the deep fascia of the perineum and is composed of two layers the superior and inferior. Anteriorly both layers are attached to either edge of the inferior border of the pubis laterally to the rami of the pubes and ischia and posteriorly they unite and fuse with the deep layer of the superficial perineal fascia—the fascia of Colles. Laterally both layers of the trigone are continuous with the obturator fascia and above the superior layer fuses at the



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vaginal cleft with the fascia about the levator ani and with the fascia which surrounds the vagina the fascia endopelvina. Along this line of fusion the inferior layer of the trigone fuses with the superior layer. Robert Frank (3) called attention to these important facts in 1917.

The urogenital trigone in the female is perforated by the vagina by the urethra and by a small opening just behind the subpubic ligament through which passes the dorsal vein of the clitoris. Immediately behind the venous opening,

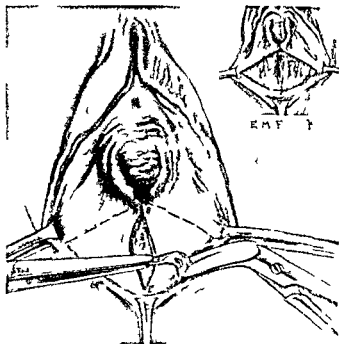


Fig. 11 The denudation of the perineum is made with an Emmett scissors

there is a thickened portion of the trigone termed the transverse ligament of the pubis

Between the superior and inferior layers of the urogenital trigone there is a closed space the deep perineal interspace. This space contains branches of the internal pudic vessels and nerves and a thin muscular sheet which is composed of the deep transversus perinei muscle posteriorly and fibers which correspond to the compressor urethrae in the male anteriorly. The deep transversus perinei arises from the tuberosity of the ischium passes behind the vagina and inserts into the central tendon of the perineum. The anterior fibers of the muscular sheet are attached in the central tendon of the perineum and pass forward closely encircling the vagina and either surround the urethra or pass in front of it in the interval between urethra and transverse ligament. This muscular sheet has been termed the urogenital sphincter.

Over the urogenital triangle there is a superficial fascia the superficial perineal fascia which is composed of two layers a superficial and a deep layer. The superficial layer which is fat filled is continuous anteriorly and laterally with a corresponding layer on the abdominal wall and thighs. The deep layer the fascia of Colles which is membranous is continuous anteriorly with Scarpa's fascia is attached laterally to the ramus of the pubes and ischia and posteriorly blends with the urogenital trigone.

Between the inferior layer of the urogenital trigone and the fascia of Colles there is a tri-

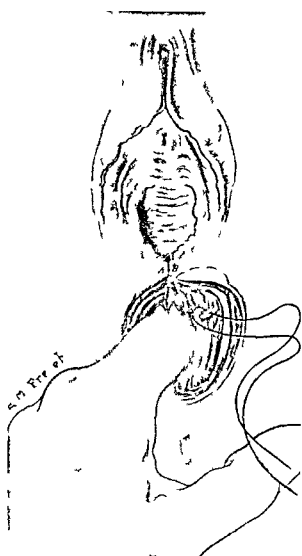


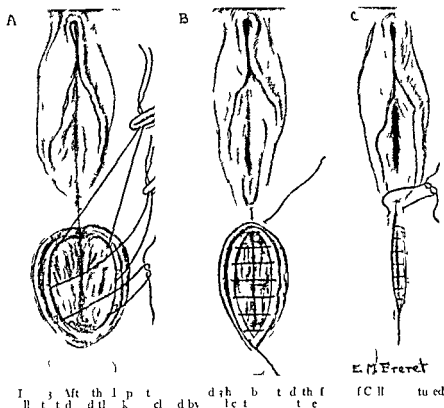
Fig. 12 Suture passes through the entire thickness of the perineum and includes the fascia about the levator ani where it is attached to the urogenital trigone. Sutures 1, 2, and 3 pass through the same tissues.

angular space the superficial perineal interspace which contains the superficial perineal muscles the long pudendal nerves the glands of Bartholin the crura of the clitoris the vestibular bulb the ischioavernosus and bulbocavernosus muscles and the superficial transversus perinei muscles attached to the ischial tuberosities and inserted into the central tendon of the perineum. In a practical consideration of the damaged pelvic floor the superficial perineal muscles except the transversus perinei and sphincter ani are of little importance.

When we consider the anatomy of the perineum it is important to distinguish between the perineum as described above and the perineal body that triangular fibromuscular mass which separates the vagina from the rectum and anus.

Under a description of the urogenital triangle of the perineum the sphincter ani should be included





This important muscle arises from the coccyx and from the ligamentum anococcygeum. It passes forward and around the anus to insert into the superficial perineal fascia and the central tendon of the perineum. Anteriorly its fibers may join those of the transversus perinei and sphincter aginæ. The central tendon of the perineum which has been frequently mentioned is located in the mid line of the perineal body in front of the anus. It is the tendon of insertion for the following muscles: the sphincter ani, the transversus perinei superficial and deep, and the sphincter vaginae.

#### FUNCTION OF THE PELVIC MUSCLES AND FASCIAE

*The levator ani.* In considering the function of the levator ani muscle it is important to remember that it is in reality composed of two muscles. The posterior portion of the muscle, the iliococcygeus from the gynecological viewpoint is relatively unimportant, as in woman its function is merely to bend the coccyx forward and to assist feebly the anterior portion of the muscle in its function. The pubococcygeus and puborectalis, the two groups of fibers which compose the anterior portion of the muscle, are the essentially important segments.

In commenting upon the function of the anterior portion of the levator ani Robert Dickinson ( )

has said: "I venture to affirm that there is no considerable muscle in the body the form and function of which are more difficult to understand than those of the levator ani, and about which such nebulous impressions prevail." One commonly meets with the idea that the levator is a kind of muscular funnel tapering to the anus and serving to pull it directly upward after defecation. This is absolutely untrue. The muscle rather resembles a horseshoe or sling attached to the pubes in front, its sweep reaching horizontally backward to encircle like a collar the rectum and vagina. Its action in woman is to drag the lower end of the vagina and rectum forward level to the symphysis.

In a detailed description of the anatomy and physiology of the levator ani Sturmdorf has clearly summarized its functions in the following statement. Concisely stated the levator ani diminishes the force of intra abdominal pressure upon the pelvic contents by deflecting the direction of that pressure, augments the resistance to pressure by closing the uterovaginal angle and obstructs the pelvic outlet against the pressure by compressing the vaginal canal. It is the tensor of the pelvic fascia, the antagonist of the diaphragm and

the abdominal muscle contracting when these opposing muscles contract and relaxing when they relax. When intact it maintains the equilibrium of the pelvic organs when its integrity is impaired equilibrium is disturbed.

*Pelvic fascia.* The pelvic fascia as that term is here used forms sheaths for the pelvic muscles and through its attachments fixes them in their normal positions.

*Fascia endopelvina.* The function of the fascia endopelvina has been a subject about which there has been much controversy. Equally eminent authorities have held conflicting views concerning its importance. With others Martin has contended that the pelvic organs are held in normal position principally by the fascia endopelvina and attributes to the pelvic muscles a relatively unimportant role in their support. On the contrary Halban and Tandler (5) who have made extensive studies of the subject contend that the pelvic muscles through their contractile force are principally responsible for the support of the pelvic viscera though they attribute to the fascia endopelvina an important role in the mechanism of pelvic support.

Regardless of either theory it is unreasonable to believe that the fascia supports the pelvic organ through sheer tensile strength for it does not have sufficient strength to withstand the more or less constant strain of intra abdominal pressure.

The more logical theory is that of Halban and Tandler in which the fascia endopelvina is considered as a fascial sheath surrounding completely the uterus, bladder and rectum and fixing the structures in their normal position but allowing a normal degree of mobility. This fascial sheath plays a part in resisting the force of intra abdominal pressure and gravity but that part is relatively less important than that of the muscle of the pelvic diaphragm which through their contractile force give the principal support to the pelvic viscera. It is obviously of the greatest importance that in operating for the correction of uterine prolapse, cystocele and rectocele the surgeon keep clearly in mind this theory which does not recognize the fascia endopelvina and the pelvic muscles as mere anatomic buttresses against displacement of the pelvic organs but which especially stresses the importance of the pelvic musculature in their support.

To the theory of Halban and Tandler there are antagonists who constantly cite as evidence against the theory cases in which there is marked levator impairment without de census of the uterus. When analyzing such cases one must not lose sight of the fact that such patients usually

have a marked impairment of the abdominal muscle which play an important part in the production and maintenance of intra abdominal pressure. The impairment in the force which these muscles usually exert as a result of pregnancy and in most instances of a degree sufficient to equalize the impairment in the function of the levator. The levator in such cases though in a relatively inefficient condition functionally is still able to maintain its influence in the support of the pelvic organs because of the reduced intra abdominal pressure which it has to antagonize.

*The perineum.* The perineum through the attachments of the urogenital trigone to the bony pelvis constitute an anchorage for the levator in the pelvic fascia and the fascia endopelvina at the pelvic outlet. The superficial muscles of the perineum have as their chief function the fixation of the central tendon of the perineum.

#### CONDITIONS OF THE PELVIC FLOOR CAUSED BY PARTURITION

When the condition of the pelvic floor which are caused by parturition are discussed it is important to define clearly the meaning of the term pelvic floor. In the present instance it is desirable

to have it include not only the musculofascial pelvic diaphragm but also the rectovaginal septum and the perineum. It does not however include the perineal septum and the tissues which form the floor of the cul de sac of Douglas.

The condition which result from injury to the pelvic floor at the time of parturition may be classified as follows: (1) general relaxation of the pelvic floor (2) rectocele (3) injury of the levator and (4) injury of the perineum.

*General relaxation of the pelvic floor.* Every gynecologist is consulted by patients who complain of pelvic discomfort from a partial loss of normal tone in the vaginal septa, the levator ani and the perineum a condition which is a result of labor in individuals whose tissues do not involute properly or of a prolonged second stage of labor in which the normal tissues have been subjected to pressure and distention without laceration. An analogy can be drawn between such a condition in the pelvic fascia and musculature and that which is so frequently seen after pregnancy in the muscles and fascia of the abdominal wall. General relaxation of the pelvic floor is an entity with which the gynecologist has to deal and one which calls for operative correction in certain cases.

*Rectocele.* Rectocele may be defined as a hernial protrusion of the rectum into the vagina always a result of injury to the rectovaginal septum at the time of parturition.

The injury of the septum which is the fore runner of a rectocele is not a constant one. In an occasional case it may occur at a point near the cervix; in other cases it may occur midway but in the large majority of cases occurs at or near the junction of the rectovaginal septum with the urogenital trigone. The laceration may occur in the midline or in one or both vaginal sulci. In either case of its situation the resulting rectocele always protrudes symmetrically in the midline of the vagina.

An examination of a microscopic section from the normal rectovaginal septum reveals the fact that it consists of a mucous membrane lined by squamous epithelium with its tunica propria a circular muscular layer a longitudinal muscle layer outside of which there is the rectovaginal layer from the fascia endoperinealis. If this arrangement of the tissues is kept in mind the injury essential for the development of a rectocele is obviously one which involves the rectovaginal fascia, the fascial partition between the rectum and the vagina. Following the injury the fascia and the retraction of the lacerated ligaments, abdominal pressure force the rectum into the hernial opening and gradually develop a hernial protrusion into the vagina.

In the course of the development of a rectocele the rectal wall dilates and becomes abnormally attached to the sacculated vaginal wall. As the protrusion increases in size nature makes an unsuccessful effort to correct the development through a general hypertrophy throughout the vaginal muscles and muscular layers. The marked thickening of the opening of a large rectocele of long standing is apparent even in a gross examination of the tissues.

An inspection of Figure 1 convinces one of the possibility of vaginal lacerations which pass through all layers of the septum and through the rectovaginal fascia with the subsequent development of a rectocele but with no injury to the fascial covering of the pelvic hypogastrum and therefore no injury to the levator ani muscle. This is a point of importance as it has been generally believed that sulcus injuries necessarily involve the levator and its fascia.

*Injuries of the levator ani and its fascia.* Text books on obstetrics usually contain vivid illustrations of lacerations in the levator ani resulting from spontaneous labor. Such illustrations are in most instances misleading for the injuries which they depict are seldom if ever encountered by the most competent observers in the routine of obstetric practice. Studdiford (8) who made careful studies of the injuries to the pelvic floor due to childbirth wrote in 1915 as follows: "I

have never been able to demonstrate in either recent or old lacerations of the pelvic floor the rupture of the filers of the pubococcygeus that is graphically pictured in many textbooks and do not believe that it takes place except in badly executed forceps delivery. After an unusually extensive study of dissections of the levator in cadavers and living subjects Sturmdorf holds a similar opinion.

The common injury to the levator ani and its fascial covering which occurs in both spontaneous and operative deliveries is one in which the levator filers normally inserted into the perineal body are lacerated in conjunction with the urogenital trigone usually in the midline of the body.

In poorly executed operative deliveries however the levator filers may be actually lacerated either transversely or longitudinally near the origin of the muscle or at a point midway between origin and insertion. When such lacerations occur it is not uncommon to see fat from the ischiorectal space protrude through the rent in the muscle.

The result of injury to the levator is by no means constant. If the more usual midline injury has occurred the muscle in its retracted position may become markedly hypertrophied as a result of an attempt on the part of nature to compensate for the impairment due to the injury. If on the contrary the muscle filers have actually been lacerated transversely the retracted portions may undergo atrophy to a degree which will make difficult if not impossible a satisfactory reconstruction of the pelvic floor. In either case the levator is no longer able to perform its function adequately in the resistance of the intra-abdominal pressure and in the maintenance of pelvic support.

*Injuries of the perineum.* When an attempt is made to reconstruct the lacerated perineum it is of the greatest importance to keep in mind that to the deep perineal fascia or the urogenital trigone the layers of the fascia about the vagina the levator ani and the rectum are attached. It is apparent therefore that any injury to this important fascia will necessarily involve the structures for which it forms an attachment.

The perineum may be lacerated completely or an incomplete laceration which reaches as far as the sphincter ani may occur. It is with the latter class of injuries that the present article deals.

The site of the injury of the perineum is variable. All obstetricians are familiar with the simple straight midline laceration which passes through the median raphe of the perineum. This type of injury is notorious for the ease with which it heals and because levator impairment and rectocele

seldom follow it. The more serious type of injury is that which passes to one or both sides of the midline and which involves the perineal muscles and fascia especially the lateral portion of the urogenital trigone. Such injuries even when primary repair has been performed often result in permanent damage to the structures involved.

The result of an injury to the lateral portion of the urogenital trigone may be a rectocele or diastasis of the levator or both. When such an injury occurs the rectovaginal fascia is usually torn from its attachment to the trigone and regardless of the care with which the repair is attempted a rectocele in the lower one third of the vagina is very likely to result. Such an injury results as a rule in the lateral retraction of the injured portions of the trigone and the levatores which are attached to its superior layer. When retraction occurs the levator cleft (hiatus genitalis) is converted from a V shaped space to a U shaped gap and the anterior margins of the levator muscles become almost parallel to each other.

In view of these facts it follows that the reconstruction of the damaged pelvic floor in which a rectocele has developed consists of three distinct operative procedures: correction of rectocele, the restoration of the levator anti to normal position and function, and the reconstruction of perineum.

The operation herein illustrated consists of the following steps: (1) incision of the rectovaginal septum, (2) removal of the rectum from the herniated portion of the rectovaginal septum, (3) excision of the herniated portion of the rectovaginal septum, (4) closure of the hernial opening in the rectovaginal septum, (5) denudation of the perineum, (6) replacement of the levator anti and reconstruction of the perineum.

1 *Incision of the rectovaginal septum.* In practically all flap splitting operations on the pelvic floor the initial incision is made along or close to the junction of vaginal mucosa and the perineal skin. The flap is elevated either by scissors being plunged into the tissues between the rectum and vagina or by a more cautious nibbling dissection with scalpel or scissors. Both methods are objectionable because they do not make for a clean cut and accurate entrance into the natural cleavage plane which lies between the rectum and the rectovaginal fascia. Very frequently when the scissors are plunged into the tissues the natural cleavage plane is missed and a false plane of cleavage is produced with the result that a part of the septum or fascia remains on the rectum. The same error is also easily made in the more cautious dissection which unnecessarily traumatizes the tissues and causes an unnecessary blood loss.

The importance of accurately entering and following natural cleavage planes has been emphasized by Bissell (1) who in an article published in 1918 on a fascia lifting operation for rectocele stresses the fact that there is a natural cleavage plane between the rectum and rectovaginal fascia which he terms a cellular area along which the rectum is easily separated from its attachment to the fascia. At the same time he describes the method by which he reaches the cleavage plane as follows: The mucous membrane of the perineum is first removed and the rectovaginal fascia exposed. This fascia is incised at about where it merges with the perineum or its remaining structures. When the fascia is incised a cellular area is entered which area constitutes the line of demarcation between rectum and vagina.

In the procedure herein described the primary incision is neither made at the mucocutaneous junction of the perineum nor at the junction of the septum and the perineum but is placed at a point 2 centimeters above the junction of the septum and the perineum because at this level there is little or no scar tissue encountered and the rectum which has been pulled downward while the septum has been elevated by clamps (Fig. 7) is fully attached to the underside of the rectovaginal fascia by a delicate areolar tissue. The entrance into the rectovaginal cleavage plane is therefore made with greater ease than when the incision is placed at a lower level where there is the greatest amount of scar tissue and where the rectum is more firmly adherent to the septum and perineum. The incision passes through all layers of the septum to the musculature of the rectum. As the scalpel passes through the septum the cleavage plane is recognized by the presence of the delicate areolar tissue which attaches the rectum to the rectovaginal fascia.

2 *Removal of the rectum from the herniated portion of the rectovaginal septum.* When the initial incision in the rectovaginal septum is completed the rectum is separated from its abnormal attachments by a finger covered with gauze. The separation is carried well beyond the area through which the rectum has protruded (Fig. 8).

3 *Excision of the herniated portion of the rectovaginal septum.* The outline of the excised portion of the rectovaginal septum will depend in each case upon the location and the extent of the hernial protrusion of the rectum into the vagina. In the case of a rectocele which protrudes through the lower one third of the vagina the removal of a triangular segment as illustrated in Figure 9 will answer the purpose while in higher rectoceles it

may be necessary to carry the lines of the excision almost parallel to each other from the initial incision to a point near the cervix. In any case the incision should be carried considerably beyond the herniated portion of the septum so that the unjured lateral portions of the septum may be used in the reconstruction.

4. *Closure of the hernial opening in the rectovaginal septum.* The hernial opening in the septum is closed by means of interrupted No. 2 chromic catgut sutures which include all layers of the rectovaginal septum, especial attention being given to the approximation of the musculofascial portion of the septum (Fig. 10).

5. *Denudation of the perineum.* When the rectovaginal septum has been closed to the level of the remains of the hymen, the perineum is denuded with the aid of an Emmett scissors as illustrated in Figure 11. Mucosa and skin only are removed. This denudation exposes the retracted portions of the perineum and prepares it for reconstruction.

6. *Replacement of the levator ani and reconstruction of the perineum.* Following the removal of the perineal skin and the vulvar mucosa, the index finger of the operator's left hand is inserted into the space which is bounded by the newly reconstructed septum, the levator muscles and the rectum. The rectum is pushed backward and the line of attachment of the levator to the urogenital triangle is located. A No. 3 chromic catgut suture is then passed from point 1 (Fig. 1) just within the fascia of Colles through the entire thickness of the perineum and is made to include the fascial sheath of the levator just where it attaches to the triangle. The needle is then brought out between the halves of the perineum and is re-introduced and passed in a similar manner on the opposite side of the body. Two additional sutures are passed in exactly the same manner at points 2 and 3 (Fig. 1) and are made to include the same tissues as are included in suture 1. In placing such sutures it is at times difficult to locate exactly the junction of the levator with the perineum with the result that the sutures include small amounts of the levator fibers, a condition which will do no harm as sutures so placed will not cause strangulation as do those placed about the bellies of the pubococcygei above the perineum. When the three sutures have been tied, the levator muscles have been drawn downward and toward the mid-

line into a normal situation and relationship without the production of any abnormal and objectionable rigid band of muscle between the rectum and the vagina. The muscles have been replaced by traction on their fascial sheaths. The normal V shaped levator cleft has been restored.

In tying the sutures (1 and 3) the retracted halves of the perineum have also been restored to a normal position and to a normal relationship with the associated fascia.

The fascia of Colles is closed by a continuous suture of No. 2 chromic catgut placed from above downward. When this suture has reached the lower angle of the perineal wound it is carried upward as a subcuticular suture and tied at the top of the wound (Fig. 13).

In view of the fact that the present article is offered as a preliminary report it is obviously undesirable to make any statistical statement at this time covering the end results which have followed its application. It is safe, however, to state that the operation was devised in the summer of 1923 and was immediately employed with success in the correction of several extremely large rectoceles. Since that time it has been extensively used by nine members of the staff of the Woman's Hospital with consistently desirable results in the cure of rectocele and in the restoration of the levator ani muscle to normal position and function.

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# A METHOD OF ASSISTING IN THE TREATMENT OF DISPROPORTION AND A MODIFIED METHOD FOR ESTIMATING THE RELATION OF THE FETAL HEAD TO THE PELVIS

PAUL THILLO SOLOMONS M.D. F.R.C.P.I. DUBLIN, IRELAND  
Maternity Hospital

**SIMPLICITY** is the keynote of success in obstetrics and I have obtained much success at the Rotunda Hospital by the following simple treatment of some cases of disproportion.

The method is chiefly used when it has been determined by the Mueller Kerr or by my own maneuver that the head will fit in and be delivered by the natural passages. It is also used in cases of both primigravidae and multiparae when there is no fixation of the presenting part and when natural delivery appears likely but when every little help is indicated. It is of special assistance in patients in whom the inclination of the pelvis is greater than usual i.e. the pubis is on a much lower level than the promontory. The head then tends to override the pubis and to give a false impression of the amount of disproportion.

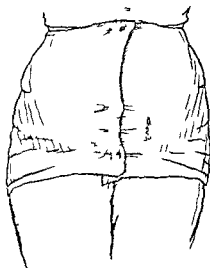


Fig. 1

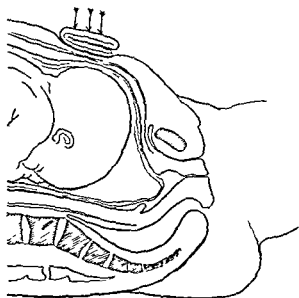


Fig. 2

It should be used as a routine in a trial of labor. The method is as follows:

A pad of gamgee tissue is folded in 4 thicknesses 11.5 cubic centimeters in width by 21 cubic centimeters in length the entire thickness being 4.5 centimeters (Fig. 1). The head is then put into the engaging position getting as much flexion as possible. The pad is next applied. The

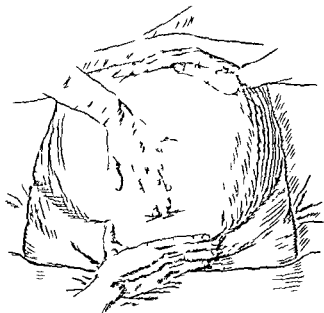


Fig. 3

operator holds the pad in position over the fetal head while an assistant applies a tight abdominal binder which is pinned from above downward. Figure 3 shows the pad and binder in position.

When the abdomen is definitely pendulous a pad should be applied in addition to the upper and pendulous part to bring the fetus in the axis of the upper strait.

I have lately practiced the following method of estimating the relation of the head to the pelvis which is a vast improvement on the original Mueller maneuver. The obstetrician sits on the right side of the patient and makes the Pawlik grip while he places the fingers of his other hand

on the fetal head and presses it downward in the axis of the superior strait. At the same time an assistant pushes on the fetal breech from the fundus (Fig. 3). If this does not give definite information about conditions the Mueller Kerr modification is practiced.

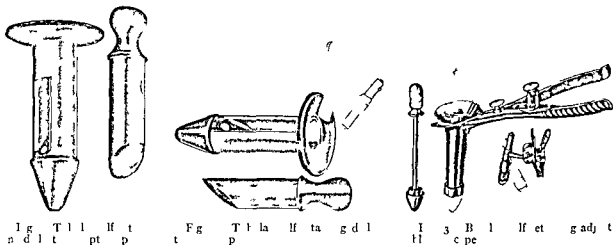
## NEW ANAL INSTRUMENTS

By W. D. JENNINGTON, M.D., Chicago

THE instruments described are (1) a tubular self retaining dielectric cryptoscope (2) a tubular self retaining dielectric anoscope and (3) a bivalve self retaining adjustable anoscope. Each instrument is 3 inches long. They are flanged at the proximal end and are conical in shape at the distal end so that they may be easily introduced. Each has a shoulder 1/2 inches from the proximal end to prevent ex-

cessive pressure and is especially adapted for use by those who treat diseases in and about anal regions with the electric current.

The cryptoscope is composed of the cryptoscope proper, an obturator and an insulated detachable lamp and it has a bridge across the fenestra extending three fourths inch from the proximal end to prevent the sphincter from obstructing the view when it is desired to examine



pulsion an assistant being thus unnecessary. The cryptoscope and anoscope are made in two diameters three fourths and one inch while the anoscope is made in but one diameter three fourths inch.

Each instrument has a detachable insulated device easily adjustable for illumination of the various fields in the region to be explored examined and treated. The insulation prevents shock in the event of a short circuit. The cryptoscope and anoscope are made of dielectric material and as they prevent the possibility of

and treat the crypts and other diseased conditions which may be exposed.

The anoscope is made up of three parts: the anoscope proper, an obturator and a detachable and adjustable insulated lamp.

The bivalve anoscope has four parts: The anoscope proper, an obturator, an insulated and detachable adjustable lamp, and a slotted plate and thumb screw for adjustment.

The lamp device which is used in the instrument was invented by Dr. D. C. McKinney of Buffalo.

## EDITORIALS

### SURGERY, GYNECOLOGY AND OBSTETRICS

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JUNE 1928

### SURGICAL PROCEDURES AND RADIUM IN THE TREATMENT OF CANCER OF THE MOUTH AND THROAT

THE use of radium in the treatment of cancer of the mouth and throat is a striking example of the misuse of a very valuable therapeutic agent.

Owing largely to the education of the public by the medical profession, many more patients with small chronic fissures or leukoplakia of the lips or minor ulcerations of the tongue or throat are presenting themselves for treatment fearing the possibility of cancer. One rarely sees at the present time a patient with extensive cancer of the mouth or throat who has not been under the care of a physician.

Of equal importance to the education of the public is the education of the medical profession to give the best possible treatment to these patients with early lesions of the mouth and throat.

Before the advent of radium the patient with a suspicious ulcer of the mouth or throat presented himself to a surgeon who excised the lesion either with knife or cautery for microscopic diagnosis. If the lesion proved to

be malignant the gland bearing fascia that drained the area was removed. If it proved to be benign the patient was well rid of the trouble and no further treatment was necessary.

Today such lesions are frequently treated with radium by the radiologist, the dermatologist or the physician with a small amount of radium at his disposal. Following this one of two things may occur. The local lesion clears up entirely only to recur however in the lymph nodes of the neck in a few months or year or the local lesion becomes more active and metastatic nodes appear in the neck. Frequently when these nodes appear the patient has a tooth removed believing it to be the cause. Later the mass in the neck is explored and found to be an inoperable metastatic carcinoma.

In cases of cancer of the larynx removal of the growth by thyrotomy with or without removal of the cartilage or laryngectomy offer the patient the best chance of cure in the intrinsic case. Although radium has been used and is still being used in intrinsic cancer of the larynx the end results are not good and the sloughing of the cartilage which frequently follows is sometimes disastrous. Recently Fortmann and Harmer recommended removal of the cartilage from both thyroid cartilages leaving only a frame of cartilage in order to avoid secondary sloughing and then using radium directly against the growth. Although their results indicate that this may be of use in inoperable cases it should not be used if the lesion can be removed surgically.

In this country radium is generally used in the treatment of extrinsic epitheliomata of



the larynx operation is not attempted Sir Wilfred Trotter of the University College Hospital London performs lateral pharyngotomy which is a great advance in the surgical treatment of growths of the epiglottis aryepiglottic folds and the postcricoid region Trotter reported the results of his first work in 1913 and has since perfected the procedure After removal of postcricoid tumors he reconstructs the upper end of the oesophagus and pharynx with a flap turned in from the neck In many of his cases the condition was entirely cleared up by surgical removal

Radium has however a distinct place in the treatment of cancer of the mouth and throat but it is being used at the present time in the treatment of many lesions for which it is doing more harm than good Patients with rapidly growing extensive cancers of the tongue and antrum who could not possibly be benefited by any surgical procedure have been entirely cured of their trouble by radium Radium seems to be of help in pre operative and post operative treatment It should not be used however to treat the questionable primary lesion which should be excised for microscopic diagnosis nor should it take the place of the removal of the gland bearing fascia of the neck

What has been accomplished by radium in the treatment of cancer of the mouth and throat has been overshadowed by the number of inoperable cases that have increased at least 25 per cent as a result of its indiscriminate use in the treatment of the primary lesion and of nodes of the neck

GORDON B NEW

## PRACTICE OF OTOTOLOGY IN THE SUMMER MONTHS

THE practice of otology in the summer months varies somewhat from that in other months One difference is ascribable to swimming which produces an otitis media especially in poorly cared for hotel

pools that are used by a large number of house guests and by the enthusiasts of the neighborhood In our large cities particularly those on inland lakes most of the public beaches are located in such a way that the shore projects at each end of the beach and tends to form a pocket which prevents to some extent the flow of water in this area Further the lavatories are often not conveniently located on some beaches there are none available so that pollution of the water by bathers who frequently stay on the beach for several hours during the hot days is encouraged

Otitis media from swimming is caused by the entrance of polluted water into the nose and throat This followed by choking or blowing the nose hard forces the infected water up the eustachian tubes to the middle ear From experience in dispensary and private practice it seems that otitis media from swimming origin is contrasted with that from acute head cold in winter time is definitely less severe and responds more quickly to early paracentesis and relatively infrequently continues to the stage of surgical mastoiditis

It hardly seems necessary now to suggest that in cases showing definite signs and symptoms of surgical mastoiditis there are several advantages in not operating at the onset of mastoid pain and tenderness In the first place it is not unusual to find that after delaying a few days the mastoid symptoms disappear and recovery is complete without operation Secondly especially is it true that a child may have mastoid pain and tenderness from conditions other than surgical mastoiditis Lastly in unquestionable cases of acute surgical mastoiditis a delay of a few days allows the surrounding tissue and the general resistance to the offending organism to increase greatly Delayed mastoidectomy in cases of uncomplicated acute mastoiditis unquestionably shortens the postoperative course

One symptom which has been found very significant in questionable cases is night pain in the affected mastoid. It is especially helpful in children who frequently have a complicated assortment of signs and symptoms.

Parenthetically surgical mastoidectomy as performed by well trained American otologists is not surpassed by our European confreres. A visit to the larger centers of Europe during the past spring revealed that our surgical work has a few definite advantages. First our work is less radical yet we do explore when exploration is indicated rather than as a matter of routine. Second we think of the postoperative appearance of our wound and therefore partially close the wound at operation which lessens the scar and greatly shortens the postoperative course of treatment and healing. Third we are infinitely more mindful that our patient shall not endure unnecessary pain and that he has a definite personal pride and modesty that should be respected.

During the past two summers the great increase in foreign travel has produced some unusual ear manifestations especially in infection of the external auditory canal due to the fungus *aspergillus niger*. Two cases observed were in patients who just returned from extensive travel, one spending 7 months on a world cruise the other months in the interior of China. A third was found in a man who spends much time traveling in this country. The diagnosis was made from a microscopic examination of the black mass in which

mycelia were found. In each case the patient sought relief from cerumen and returned with the suggestive black thick secretion involving a small area of the canal membrane.

Furunculosis of the canal is also a definite feature of otology in the summer months yet it does not seem to give evidence of any peculiar seasonal variations.

Examination of the deaf shows a marked increase during the warm months. In searching for a reason it seems that possibly the out of door life at this time of year impresses the deaf with their great limitations and so encourages them to seek relief. Also the education of parents and children by the investigation of school children by otologists and the publicity in recent years of our otological societies and their committee has greatly encouraged examination. The mechanical devices for the aid of deafness show a marked improvement which is encouraging in that further refinement will develop as more demand is expressed for this means of relief.

The correction of the mild conduction type of deafness constant or intermittent as found in children due to a partial closure of the eustachian tube from adenoids or mild nasal abnormalities is a striking seasonal feature. Not infrequently inattentive and scholastically poor students are completely changed by relief of their deafness due to treatment of the eustachian tube or indirectly by correcting nose and throat conditions.

HORACE R. LYONS

# MASTER SURGEONS OF AMERICA

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## LOUIS SAMUEL McMURTRY

**B**OIRN in Harrodsburg the seat of the first capital of Kentucky on September 14 1850 of Scotch descent Louis Samuel McMurtry was reared and educated in the Blue Grass the aristocratic section of the State and died in Louisville the seat of his labors for over thirty five years on February 1 1924

Danville was long the cultural center of the State and it was here that young McMurtry obtained his academic education receiving his degree in 1870 His alma mater Centre College numbered many distinguished names among its alumni Unquestionably the atmosphere in which he at this time lived must have fired his ambitions and desires and have played no small part in determining him not only to study medicine but to follow in his professional career along the same lines as the immortal McDowell

At Danville McMurtry came early most likely during his academic studies under the influence of Dr John D Jackson a scholar a student a gentleman and a philosopher as well as a surgeon of distinction He read medicine with Jackson for a year or two dissecting the human body and becoming well grounded in anatomy before entering medical college

Is it to be wondered at that he was enthusiastic in his studies or that he graduated after his course at Fulane with the honors of his class? His graduation in 1873 was followed by an internship at the old Charite where he was chief medical resident During this time he presented several papers bearing upon important medical topics His impressions upon his professors during these student days was so great that he was invited to make the address to the graduating class 2 years later

Returning after his graduation to Danville he took up the active practice of medicine and surgery With 2 years intermission during which time he taught anatomy in the University of Louisville he continued his practice in the community until he moved to Louisville in 1888 These were busy years Although the demand on his time in general practice was very great he continued a diligent student of surgery and was one of the early converts to Listerism having been a student of the work of Pasteur He was a life long admirer of the great French scientist During this period his surgery was not confined as later to abdominal and pelvic work as may be noted by his papers which include the report of a successful ligation for aneurism of the subclavian artery and papers on general surgery



LOUIS S. MCMURTRY  
1850-19 4

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As stated earlier in this sketch he had been much impressed with the work of McDowell and determined to confine his work to abdominal and gynecological surgery which had become recognized as a distinct specialty as a result of Lawson Tait's studies in pathology. He therefore made a tour to Birmingham and became a student of this great and incomparable master. Perceiving on his return to his native State that his work demanded a wider field of usefulness he removed to Louisville. The demands upon him were great his reputation as a surgeon had already been made. He was at this time widely and favorably known and his state medical association honored itself and him by electing him as its president in 1888.

It was about this time in his professional career that McMurtry became the intimate of Howard Kelly and Joseph Price. With the latter two he was most active in society work and in the promulgation of the newer concepts of the pathology of the female pelvis and its treatment and in preaching the doctrine of aseptic surgery. His reputation became international and he took a very prominent part in medical societies his discussions being at all times forceful logical and convincing. The early advances in American surgery its rapid strides and the marvelous development of abdominal and general surgery was in a large measure due to these pioneers all of them brilliant operators and teachers blazing the trail which we now so easily tread.

McMurtry had become internationally known 10 years before this period as a result of his labors not only in establishing the claim of McDowell to priority in the field of ovariectomy but also in taking up the work of his preceptor Dr. Jackson in fostering the erection of a memorial to the great McDowell.

In 1890 McMurtry was called to the chair of abdominal surgery and gynecology in the Hospital College of Medicine which chair he filled with distinction being shortly made President of the faculty and occupying the appointments in the school until it was merged with the University of Louisville in 1910. He was most active in bringing about the merger of the medical college in Louisville and became president of the Medical Department of the University of Louisville remaining as such until the time of his death.

Of most genial disposition he was quick to resent what he deemed a wrong or an injustice. A friend of the young striving beginner he demanded merit and hard work. Cultured and courtly in manner he was a raconteur of the rarest order and loved nothing better than association with congenial fellow men. He was as all great men are a lover of good literature and of the poets. His life and work was in itself a poem his operations were epics. He was a brilliant conversationalist and his travels and reading made him a most interesting companion.

He was particular in dress as he was in choice of language and because of his charming manner he was often called upon not only to preside at meetings but to make addresses public and professional.



As a surgeon of keenest judgment as an operator of brilliant and marvelous technique as a diagnostician of wonderful acumen insight and sound reasoning McMurtry had no superior and few equals certainly in pelvic surgery His early work with that of Price and Kelly has left its mark upon American surgery of today

Doctor McMurtry in addition to his membership in the American Medical Association of which he was president in 1905-1906 was an active member of his state and county societies a fellow of the British Gynecological Society and of the Edinburgh Society of Obstetricians and one of the founders of the American Society of Obstetricians and Gynecologists of the Southern Surgical Association and also of the American College of Surgeons in which he took a most active interest He was a member of the American Surgical Association and at the time of his death was president of the Kentucky State Board of Health which post he had held since 1919

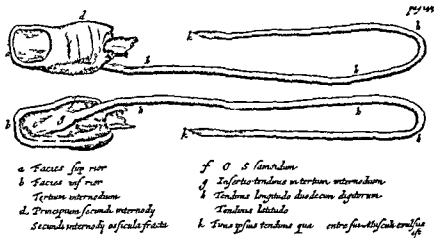
During the great World War he organized the first unit in Kentucky that saw oversea duty He was appointed by the Surgeon General as Military Aid to the Governor which post he filled until its duties became too onerous

His illness was a short one death being due to pneumonia of four days duration When the time came to join the innumerable caravan he went

Like one that draws the drapery of his couch  
about him and lies down to pleasant dreams

LOUIS FRANK





P E T R I  
DE  
MARCHETTIS

PATAVINI  
EQUITIS MARCI

DM Pat Gym fca Chiruzg a vltim  
vltim vltim a vltim c m Prof fignis

OBSERVATIONUM  
MEDICORUM  
RARIORUM SYLLOGE.



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# THE SURGEON'S LIBRARY

## OLD MASTERPIECES IN SURGERY

By WILLIAM BROWN M.D. F.A.C.S. OMAHA

### THE MEDICOSURGICAL OBSERVATIONS OF PIETRO MARCHETTI

**A**MONG the numerous surgical Observations published during the seventeenth century the little book of Petri de Marchettis or Pierre Marchetti takes high rank for though small in compass physically it holds between its cover an epitome of the advance that surgery had made during the preceding century. Marchetti was born in 1589 just as Iarvis was passing off the surgical stage and lived until 1673. A native of Padua he became first professor of surgery and later professor of anatomy at the University where he was distinguished as a fearless and clever operator.

In 1664 his *Observations* appeared according to Haller sixty eight in number but the volume illustrated here was published in 1665 and contains but sixty three. Following these are small books entitled (a) Concerning Fistulas of the Anus and Rectum (b) Concerning Ulcers and Fistulas of the Urethra and (c) Concerning Spina Ventosa. The book is entitled A syllogism of the rare medico surgical observations of Petri de Marchettis of Padua Knight of St Mark formerly professor of surgery and now professor of anatomy in his native University Amsterdam from the work shop of Petri le Grand 1663.

The great interest displayed in wounds of the head is particularly prominent in all the surgeries of the sixteenth and seventeenth centuries. Other forms of operative work like the stone and hernia were left to the barber surgeons and charlatan but for some reason or other these head wounds were considered in the domain of the educated surgeon. In all parts of Europe there was constant warfare and war meant hand to hand fighting so that clubs came into use and broken heads were common. Thus material for observation and treatment was abundant but does not seem to have been used for scientific purposes. The surgeon advised trephining and if he wrote a book or treatise described his instruments and technique after which he considered his work done. From Brunschwig on there are illustrations of trephines and saws the prognosis and differentiation between concussion and compression are hinted at as by Berengarius but of detailed examination with the findings there is little said.

Marchetti in his clinical observation excelled his predecessors. A report of one of his cases reads almost like one of the present day and while in many

of the old history diagnosis is difficult Marchetti plainly material before the reader's carefully that diagnosis can be hazarded with pretty fair confidence that it is correct. If he drew any conclusion from his clinical data he did not publish them nor make any attempt to establish the relation between cause and effect. This is seen particularly in his Case of a brain case in which by his description he uncovers the key to cerebral localization but then stops and says nothing more. He describes the case as a large wound of the right side of the head in which a small piece of bone was driven in through the membranes into the brain and on this account above the other symptoms common to the wound in this was the symptom proper to this (wound) paralysis of the opposite arm and tongue so that he was able neither to speak nor move the right arm. For six days Marchetti tried all sorts of treatment in the way of dressing and ointments without avail. He then decided that a piece of bone was present which having been grasped by a volsellum I drew out to it was attached a portion of the pia membrane and of the brain whence hardly half an hour later he recovered the motion of the tongue and arm. Several other brain cases are described with equal care one of particular interest in which traumatic epilepsy was cured by removal of a piece of bone. He believes that unless the signs of compression are present cranial wounds are not particularly dangerous. This portion of the work reveals the author as a surgeon of excellent judgment and it is a disappointment to find later that Marchetti believes in the Galenic doctrine that nerves and tendons should not be sutured because of the vital fluid that flows through them and attacks Severino for advocating suture of these structures. He says

Indeed I have seen nerves or tendons ungaurdly sutured by certain Barbers followed by convulsions and the death of the patient. He publishes only one illustration which represents a thumb bitten off by a horse with avulsion of the flexor tendon at its junction with the belly of the muscle. It is a little difficult to understand why this case should have been singled out for illustration.

Marchetti's conclusions about penetrating wound of the chest are remarkable in that he lets them alone unless indications for active interference arise. He operates upon patient suffering with empyema so his expectant treatment is dictated by judgment and not by fear.



surgery will be available for the medical profession. The volume is loose leaf so that material may be replaced from time to time as advance is made in the art and science of surgery. J. A. WOLFE

THE first edition of *Emergencies of a Civil Practice* which was published in 1915 by the late N. C. Morse has been revised and rewritten by Amo Watson Colcord. It deals with the class of work in which the attending physician is called on to think quickly and to act with rapidity and good judgment. The thirteen chapters contain much interesting information and the description of method which the writers have found best. The subjects considered include removal of foreign bodies from the airway, treatment of asphyxiation, surgical emergencies, medical emergencies, fractures in different locations, amputations, obstetric emergencies and various types of poisonings.

The propriety is questionable of including in a book of this type the brief descriptions of such surgical procedures as gut resections, treatment of ruptures of liver, spleen and pancreas, of acute appendicitis, of ruptured ectopic pregnancy, of strangled hernia, caesarean section and the wiring of the fractured mandible.

On page 120 F 561 shows a proctocolic fistula which is captioned "Meinecke's hypodermic apparatus." On page 127 Colcord says that "no doubt the permitting of first aid classic for wounds has been productive of much wound infection." He found that one third of this infection had been first treated with iodine.

The writer seldom boils his instruments but is content to sterilize them in denatured alcohol slightly over neutralized with caustic soda. In his opinion a general anesthetic is nearly always needed in the removal of needles. In his discussion of poisoning (an emergency?) the writer makes no mention of the antigen treatments.

Although this volume is interesting it is a far cry from Lejar.

FREDERICK CHRISTOPHER

IN a very excellent monograph<sup>2</sup> Fitzwilliams has presented the modern surgery of the tongue. It is based upon a wealth of material from the London hospitals and the literature. The chapter on microglossia and fissures of the tongue is full of interest and very complete. Other chapters include injuries, inflammations, leucoplakia, syphilis, tuberculosis and actinomycosis of the tongue. There is a discussion of submaxillary calculus, ranula and thyroglossal tumors and cysts.

Of greatest value is the one hundred pages devoted to cancer of the tongue. In his preface the author says that "cancer of the tongue in place of being

the hopeless disease that the laity and many physicians and some surgeons seem to think it is just as curable in its early stages as is cancer elsewhere. It is a duty therefore for each medical man to instruct the public as to the curability of cancer when recognized and treated in early stages.

The clinical characteristics of the hard edged ulcer and the papillomatous excrescence are clearly brought out.

The author favors surgical methods which he fully describes but includes in account of treatment by diathermy, radium, X-rays and various other methods.

The text is clearly written and made more vivid by the many illustrative cases. It is a book full of interest to every medical man and may heartily be recommended. FREDERICK CHRISTOPHER

DR. STODIE has limited himself in *Nasal and Rhinological Disorders*<sup>2</sup> to a description of nasal diseases which have as symptom headache and disorders neurological phenomena. The origin controlled by nasal treatment and rhinological phenomena apparently not controlled by nasal treatment and rhinological phenomena. Here are epitomized numerous articles he has published on rhinological problems with the hope of arousing the interest and cooperation of rhinologists and neurologists and in this way to establish connection with rhinology.

A table of the fundamental facts on which Dr. Stodier's theories are based is given in the introduction. Dr. Jonathan Wright on the minor pathological variety of changes observed in patients suffering from material from Dr. Stodier's case.

The history of vacuum treatment of headaches of great interest. Dr. Stodier distinguishes two types: one a symptom of a disease which is easily recognizable and limited by the duration of the disease; the other arising in some obscure condition of which the headache is the only symptom. It is with this headache that he is chiefly concerned and it is in such cases he believes the rhinologist can help. Such headaches are relieved by cocaine, permanent or long continued relief can come from astringents, but removal of the anterior part of the middle turbinate may be required.

About 50 pages are given to a detailed account of the syndrome of nasal ganglion neurosis. The description of the sphenopalatine ganglion with its anatomical relationship is full and clear. The ganglion is easily reached since it is very constantly placed above the posterior tip of the middle turbinate and is separated from the nasal cavity by a small amount of areolar tissue and the nasal mucous membrane.

The discussion on hyperplastic sphenoiditis which extends over 100 pages may be read with advantage.

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One is not amazed that sensory phenomena can arise from disease in it but that they are uncommon in the experience of many competent neurologists. The question may well be asked: Are such disturbances uncommon indeed?

The relation of the Vidian nerve to the base of the skull is the cause of many of the syndromes especially those which are peripheral in extending from the mastoid to the maxilla and the orbit. In such cases, by means of the oil of the gland and Dr. Stiles is satisfied that it be not in the least a thorough knowledge of the anatomy of the part and a considerable knowledge of the function of the chapter concludes with a list of the author's technical work.

The chapter on neurological problems in rhinology deals with the relation of the nose to the brain and the eye. The nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye. The author is of the opinion that the nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye.

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J. G. O'WILL

It is a difficult task to make a definition of medicine. All men are surgeons, potentially, but many are not. A surgeon is a man who has a certain amount of knowledge and skill in the use of the knife. The author is of the opinion that the nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye.

The first part of the book is devoted to the nose and the eye. The author is of the opinion that the nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye.

The third part of the book is devoted to the nose and the eye. The author is of the opinion that the nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye.

The description of the paraphernalia for traction and suspensions seems inadequate. The one hundred and twenty pages given to the treatment of special fractures comprise an excellent compendium of this subject although fracture of the femur and spine scarcely have a place in a minor surgery. The description of skeletal traction. Part five deals with the joints and includes sprains, joint effusions, dislocations, and some account of orthopedic treatment. The sixth part includes the lesser gynecological procedures and catheterization. Part seven takes up the lesser surgery of the eye, nose, ears, larynx, and mouth.

The volume represents a great amount of serious effort and contains a mine of valuable information. Certain omissions and scope which exceeds the title do not prevent the reviewer from according it hearty praise and commendation.

FRANK CHASTOTTER

This monograph of 18 pages, Roche begins with a historical review of the history of the nose and the eye. The author is of the opinion that the nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye.

The matter of technique is given in detail, attention being centered on the danger which may arise from its faulty execution. To avoid the possibility of error, the author is careful as to the selection of cases for rhinology. So indirectly, he has to rhinology as a routine procedure that he states emphatically that it should never be resorted to except when a diagnosis is not clear from other means.

The author's remarks following rhinology are: 1. The use of the nose as a diagnostic tool for the nose. 2. The use of the nose as a diagnostic tool for the eye. 3. The use of the nose as a diagnostic tool for the ear.

A very good detailed description of the normal physiology of the nose. The author is of the opinion that the nose is a reflex phenomenon and is related to the fifth nerve and the other nerves of the face. The chapter deals with the role of the sympathetic system in the nose and the eye.

Description of the various physiological changes as found in the process of stenosis, tumor, tuberculous inflammation, etc. and a discussion of the value of rhinology in the differential diagnosis of obstructive nasal pain and of the value of rhinology in the presence of shadow in the X-rays of the nose and the relation of the nose to the abdominal tumor and the kidney, pelvis, and ureter are given in the author's statements carrying weight as a result of his excellent judgment and his commendable character.

The book is written with commendable clarity and will be a great help to all who wish to familiarize themselves with the technique of indication for rhinology and the danger which may follow its use.

H. L. KRETSCHM

By P. E. R. H. M. A. M. I. M. C. H. (C. Q. B.) L. R. C. D. (Eng.) W. B. F. R. C. S. J. W. L. M. Wood & Co. Ltd. 1917

**PAPIN** surgeon of St Joseph's Hospital in Paris has just completed a beautiful two volume work on surgery of the kidney. The author has brought the literature on each subject up to date. However it should be stated that the bibliography is almost entirely French with some mention of German and less mention of English and American workers. The normal anatomy of the kidney, gross topographical and microscopic is given in many pages and is illustrated with color plates. Particular attention is given to the kidney pelvis, drainage and blood supply of the parts.

To correlate his excellent chapter on renal anomalies the author first enters into a brief history of the development of the kidney. He then deals at length on the anomalous kidneys.

Nitrous oxide gas with no preliminary tests seems to be the favorite anesthetic. Carbon dioxide ethylene is also used. Regional anesthesia is briefly described.

After discussing the instrument used in renal surgery he writes in detail the indication for and the technique of each method applicable to the kidney. The lumbar extirpation of the ureter is usually given first choice. The author recommends nephrotomy for exploratory purposes and concludes that its effect upon the renal parenchyma is a slight loss of renal tissue through scar but the remainder of the renal cells undergo compensatory hypertrophy.

Posterior and anterior pyelotomy are stressed from the viewpoint of producing hemorrhage of injured anomalous or supernumerary blood vessels. However all kidney pelvis work seems to be in agreement with recent American ideas.

In nephrectomies separate ligation of the renal vessels is preferred. Clamps which are left on the pedicle are used only when nothing else can be used. In secondary nephrectomies the subcapsular method is recommended. Adhesions, large kidneys, hemorrhage, abnormal vessel, wounds of the inferior vena cava, opening of the pleural cavity, wounds of the diaphragm and nerves, opening of the peritoneum and intestines and injury to the suprarenals are all pointed out as complications of nephrectomies. Immediate postoperative accidents are operative shock, anuria, hemorrhage, hæmaturia and wound infections, late accidents are fistulae and hernia of the abdominal wall.

In nephrectomy for tuberculo is the author advocates complete removal of the fatty capsule, cauterization of the ureteral stump and drainage of the wound.

For nephropexy the methods of Guyon and Edebohl are mentioned first. The author supplements their method by using the fatty capsule for a basket to maintain fixation. Elastic operations on the kidney pelvis are fully described but no opinion is given as to the efficacy of the different methods of procedure.

Surgical procedures in nephritis include decapsulation and mental implantation of the kidney. Experimentally better results are obtained with the latter procedure.

The author includes the unilateral ligation of a ureter, rarely done by nephroptosis of the same kidney with the nephritis of the opposite organ. Bilateral ureteral ligation causes death of a uræmic nature, ligating any renal artery, small or large, causes death of that portion of the kidney supplied by the ligated artery. Anomalous venous even a renal vein can be ligated with a rather satisfactory formation of collateral venous circulation.

It is the first in all methods of diverting the urine through a path other than the bladder that is a long thin tube to the skin or transplanting the ureter into the trigone into the bowel at various intervals, leads to a certain degree of hydronephrosis and a certain amount of pyelonephritis. The illustration of ureteral transplantation are well worth reviewing.

The two volumes are highly recommended to anybody who has a reading knowledge of French and who is especially interested in surgery of the kidney.

HARRY CULVER

**THE** past 15 years have seen a material change in the literature of malignant tumors. Previous to that time much attention was given to various theories of the origin of tumors, the best known of which was Cohnheim's theory of embryonal tissue displacement. All of these theories were largely the result of abstract reasoning based upon histological observations. Today the study of the etiology of malignant tumors tends to ignore histological material and to be directed along three different lines of investigation: (1) the transplantation of tumors from one animal into another, (2) the relation of heredity to the incidence of tumors and (3) the experimental production of tumors in lower animals.

Lewin in this volume\* of 231 pages has reviewed the literature on the etiology of malignant tumors. The extent of his labors is indicated by the fact that at the end of the volume is a bibliography of 23 closely printed pages giving references only and not titles of the articles cited. American medical literature is rather well represented. Carrel, Jorstad, Lambert, Lewin, L. Loeb, Murphy, Rous, Slye, Tyzzer, Woggon and Wells each has 2 or more citations. The author is convinced that regardless of any possible microbic origin, the problem of the etiology of malignant tumors stands in close relation to immunobiological processes. In the development of malignant tumors there are two factors, namely, an extrinsic factor (irritation) and an intrinsic factor (inherited disposition including immunological phenomena).

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Ch. G. R. I. I. By D. Edm. I. P. F.  
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ment at intervals of several months. And this is the reason that his results are not encouraging.

In this day when the method of treating unilateral phthisis by extrapleural thoracoplasty has been so widely accepted and the method of artificial pneumothorax so well understood, this booklet by Tidley must be regarded more in the light of a delightful bit of historical reading, even though his indications and his rationale for stripping the chest with adhesives are as good and sound as they ever were.

The reviewer is pleased to have had the opportunity of reading this little monograph and is sure that any one interested in the subject of tuberculosis will also enjoy it.

RALPH B. BETTMAN

RIVIERE in an excellent little book has described the history, indications, and technique of artificial pneumothorax in the case of pulmonary tuberculosis. A short article dealing with other surgical procedures such as phrenic excision, pneumolysis, and extrapleural thoracoplasty is appended.

The description of the technique is very good and if the reader would adhere to the methods and precautions laid down, dangers would be minimized to the lowest possible point. The book is in all senses of the word a practical handbook, although the reviewer feels that it could be made even more practical by the inclusion of additional illustrations, roentgenograms, and photographs.

I AM B. BETTMAN

T. P. M. R. N. S. C. I. V. I. d. d.  
Tu. Co. k. 1 Lo. d. U. M. D. (Lo. d.) F. R. C. P. d. d.  
N. w. k. 1 Lo. d. U. M. D. (Lo. d.) F. R. C. P. d. d.

THE more one sees of practical surgery the more one is impressed by the relative frequency of unforeseen complications and when one carefully thinks out the cause of the troubles it is only to find that most of them could be prevented. This statement in the preface of Watson's book on the *Fundamentals of the Art of Surgery* expresses the underlying sentiment of the volume. The author definitely states in regard to operative skill. The success of an operation depends on much more than this: it entails first a careful and thorough examination of the patient, second an adequate preoperative preparation, third a careful anesthesia and an equally careful selection of the anesthetic, fourth the proper organization and equipment of the place for the operation, fifth due appreciation of the powers of the patient and his ability to stand the strain to be imposed upon him, sixth adequate facilities for postoperative treatment, and lastly, directions for the after care of the patient. These are the topics discussed by the author. His presentation is excellent in that he combines definite information with sufficient of the romance of medicine to make easy and delightful reading.

It may be discreet to call attention to an error on page 49. The author states that Bayliss advises the use of a 6 per cent solution of gum acacia in 9 per cent sodium chloride solution to be given intravenously. This no doubt is a typographical error and should read 0.9 per cent sodium chloride solution.

J. A. WOLFER

F. N. M. T. L. S. A. S. K. B. J. H. H. W. T. S.  
M. B. S. (Lo. d.) F. R. C. S. (E. S.) N. w. k. P. I. B. H. B. 97

## BOOKS RECEIVED

Books received are acknowledged in this department and such acknowledgment must be regarded as a sufficient return for the courtesy of the author. Selections will be made for review in the interests of our readers and as space permits.

**POLIOMYELITIS WITH SPECIAL REFERENCE TO THE TREATMENT.** By W. Russell MacAusland, M.D. Philadelphia: Lea & Febiger, 1927.

**CONVALESCENCE: HISTORICAL AND PRACTICAL.** By John Bryant, M.D. New York: The Burke Foundation, 1927.

**PROCEEDINGS OF THE TWENTY-FIRST ANNUAL CONVENTION OF THE ASSOCIATION OF LIFE INSURANCE PRESIDENTS HELD IN THE HOTEL ASTOR.** New York: December 5 and 9, 1927.

**MEDICAL RESEARCH COUNCIL: THE TOXAEMIAS OF PREGNANCY: A CLINICAL AND BIOCHEMICAL STUDY.** By J. N. Cruickshank, J. Hewitt, and K. L. Couper. London: His Majesty's Stationery Office, 1927.

**AIDS TO GYNECOLOGY.** By Richard I. Tottenham, B.A., M.D., D.P.H. (Univ. of Dublin), F.R.C.P. 7th ed. New York: William Wood and Company, 1927.

**LE FRATTURI DEL GOMITO.** By Dott. Franco Rossi (Publication of the Clinica Chirurgica Dell' Regia Università di Milano). Milan: Coop. Grafica Degli Opera, 1927.

**LAS PERITONITIS FOR PERFORACION.** By Dr. Elpidio Stincer. Havana: Compania Impresora Industrial, 92.

**BIRTH, STILLBIRTH, AND INFANT MORTALITY STATISTICS FOR THE BIRTH REGISTRATION AREA OF THE UNITED STATES, 1915.** Eleventh Annual Report—Part I: Summary and Rate Tables and General Tables. Washington: United States Government Printing Office, 1927.

**THE ART OF ANAESTHESIA.** By L. J. L. Fla. G. M. D. 4th ed. Philadelphia and London: J. B. Lippincott Company, 1928.

**LEHRBUCH DER ROENTGENDIAGNOSTIK MIT BESONDERER BERUECKSICHTIGUNG DER CHIRURGIE.** Edited by H. R. Schinz, with the collaboration of W. Baensch and I. Riedel. Leipzig: Georg Thieme, 1928.

**KURZE GESCHICHTE DER CHIRURGIE.** By W. von Brunn. Berlin: Julius Springer, 1928.

**TRoubles WE DON'T TALK ABOUT!** By J. F. Montague, M.D., F.R.C.S. Philadelphia: London: Chicago: Montreal: J. B. Lippincott Company, 1927.

**GYNECOLOGY FOR STUDENTS AND PRACTITIONERS.** By Thomas Watts Eden, M.D., C.M. (Edin.), F.R.C.I. (Lond.), F.R.C.S. (Edin.) and Cuthbert Lockyer, M.D., B.S., F.R.C.S., F.R.C.I. 3rd ed. New York: The Macmillan Company, 1928.



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Benjamin Franklin

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a very satisfactory recovery and was discharged October 29

CASE 6 A white female aged 30 years was admitted to the University Hospital on August 18 1926 with a diagnosis of acute appendicitis of 24 hours duration. The patient was also 5 months pregnant. At operation an acute gangrenous appendix was found with diffuse peritonitis. The appendix was removed four drains were inserted and the patient improved slowly. On the third day following operation she developed a marked paralytic ileus and began to vomit profusely. Enemas were given and the stomach was washed out but this did not relieve her. On the basis of the chemical changes in the blood intravenous medication a begun 10 per cent glucose and 5 per cent sodium chloride solution being used. During the first 14 350 cubic centimeters were given three times and 400 cubic centimeters of the same solution were given twice on the second day. Enema and lavage were repeated as often as necessary. The enemas were never effectual but at each lavage there was removed a large quantity of brownish fecal material. On the sixth day of intravenous medication the patient's general condition seemed somewhat better but the distention and obstruction were not removed. Under local anesthesia a colostomy was done the transverse colon being used. A large amount of gas escaped at operation. The patient seemed remarkably improved. Intravenous medication was continued 400 cubic centimeters of 10 per cent glucose and 2 per cent sodium chloride solution being given twice daily for 3 days. Lavage and enema were still continued. Three hundred cubic centimeters of 5 per cent salt solution were put directly into the enterostomy tube on two occasions. Following this treatment the patient seemed much improved but aborted on the eleventh day after the first operation. From this time on he made a very satisfactory recovery and was discharged on September 19 as cured.

CASE 7 A white male aged 35 was admitted to the University Hospital on August 6 with a ruptured appendix and peritonitis of 3 days duration. On admission the patient was very toxic and had been vomiting at intervals for 2 days. On the basis of the chemical findings in the blood 500 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given intravenously before operation. At operation a ruptured appendix with diffuse peritonitis was found. The appendix was removed and the abdomen was drained. The patient was given 1000 cubic centimeters of the same solution intravenously in the first 12 hours after operation. The blood was taken for analysis the following day with the result shown. The patient made a satisfactory recovery and was discharged from the hospital on August 26.

CASE 8 A white male aged 16 was admitted to the University Hospital on April 7 1926 with a diagnosis of ruptured appendix and general peritonitis of 4 days duration. At operation the appendix

was removed and the abdomen drained. Five days after the operation the patient developed a paralytic ileus and began to vomit large quantities of brownish material. The stomach was washed out and enemas were given. No intravenous medication was given at this time but only isotonic saline. Sixteen days after operation he developed a pelvic abscess which was opened April 27. There was considerable hemorrhage from the abscess cavity and the patient was in a critical condition. At this time the patient was given the first intravenous injection of 2 per cent sodium chloride and 10 per cent glucose but he died on May 2. It will be noted that at no time was sufficient sodium chloride given to bring the blood chloride to normal hence the associated toxemia as insufficiently treated.

CASE 9 A white woman aged 50 was admitted to the University Hospital on August 27 because of partial intestinal obstruction of 4 or 5 days duration. This was apparently due to adhesions from an operation for appendiceal abscess 3 years previously. At this time the appendix was not removed but the abscess merely drained. On admission to the hospital the patient was in a state of profound shock with a rapid pulse markedly distended abdomen and fecal vomiting. On the basis of the chemical changes in the blood intravenous medication was commenced. During the first 2 days one liter of 5 per cent sodium chloride solution and 10 per cent glucose were given and 500 cubic centimeters were administered on the third and fourth days. Very little was given by mouth at this time but the stomach was washed out repeatedly and enemas were given. The patient's condition on the fifth day after admission had improved some but she still had partial obstruction. She was operated on September 1 and many adhesions were found to be present and the gut was firmly adherent to the old scar causing obstruction. The adhesions were released and the obstruction corrected. Four hundred cubic centimeters of the intravenous medication described above were given daily for 4 days. The stomach was washed out and enemas were given which were now more effectual. She improved very much for the next few days but on the tenth day after operation she developed a fecal fistula her wound broke down and the fecal fistula truned for 4 or 5 days and then closed. She improved very rapidly for the next 4 days except for heart attacks. Three weeks from the day of operation she developed a bronchopneumonia and died a few days later although for a long time previously there had been no symptoms of obstruction or toxemia and the blood was as normal.

CASE 10 A colored male aged 12 years was admitted to the University Hospital on August 20 with symptoms of intestinal obstruction of 7 days duration. The patient was markedly dehydrated the abdomen was greatly distended the pulse was rapid and the patient was in a state of shock. Anemia was given but was not effectual. Five hundred cubic centimeters of 5 per cent sodium chloride solution and 10 per cent glucose were given soon after

admission. A few hours later the patient was operated on. An internal hernia was found which consisted of a large portion of the small bowel passing through the foramen of Winslow into the lesser peritoneal cavity. The proximal loop was markedly distended and the distal loop collapsed. The hernia was reduced and the patient was returned to the ward in fair condition. Nothing was given by mouth and enemas were ordered as necessary. Three hundred and fifty cubic centimeters of intravenous solution were given twice daily for 3 days. On the tenth day after operation the patient developed a fecal fistula which closed spontaneously in 3 or 4 days. He was discharged from the hospital September 24 in good condition.

**CASE 11.** This patient entered the hospital with an acute epidemic encephalitis. It was characterized by medullary symptoms including an almost total paralysis of the vagus resulting in marked abdominal distention due to paralytic ileus. The development of the chemical signs of toxemia secondary to this ileus can be observed in the table. Chloride treatment was commenced and although he died from respiratory and renal failure the blood chlorides at the time of his death had been brought up to normal.

**CASE 12.** A white female aged 38 was admitted to the University Hospital March 24, 1927, with a diagnosis of cholecystitis of several months duration. At operation a very much inflamed gall bladder was found but no stones. In addition to a cholecystectomy the appendix and a cystic ovary were removed. Three or four days following operation the patient developed a marked paralytic ileus with great distention and began to vomit large amounts of brownish material. A duodenal tube was passed and enemas were given. Four hundred and fifty cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given twice a day for 4 days and then 450 cubic centimeters of 10 per cent sodium chloride and 10 per cent glucose three times a day for 3 days. The patient's condition improved and she made a satisfactory recovery.

**CASE 13.** A white male aged 60 was admitted to the University Hospital February 14 because of hypertrophy of the prostate and increasing symptoms of obstruction of 7 months duration. On entrance the patient was in very bad condition and seemed to be on the verge of uræmia. He was given large amounts of fluid for 10 days and then a suprapubic cystotomy was done on February 23. The prostate was removed on March 8. Following this operation the patient was very sick and toxic and began vomiting. For 3 days the patient was given 900 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose intravenously. The urine output became much better the toxic symptoms subsided and his vomiting ceased. The patient made a very satisfactory recovery and was discharged from the hospital as cured on April 4.

**CASE 14.** This patient entered the hospital with vomiting of pregnancy. Because of the presence of large quantities of acetone in the urine she was

thought to be suffering from acidosis and was given 2 per cent sodium bicarbonate by rectum. The blood chemistry on the succeeding day, however, showed a marked alkalosis which had probably been aggravated by the alkali treatment. That this was not the only factor is shown by the persistence of the acetoneuria and alkalosis after the discontinuance of alkali therapy.

**CASE 15.** A colored male aged 25 was admitted to the University Hospital February 13 following a gunshot wound of the abdomen a few hours previously. The bullet had penetrated the abdomen near the midline just below the umbilicus. Immediate operation showed ten perforations in the small intestine and a great deal of blood in the peritoneal cavity. The perforations were closed and the abdomen was drained. The patient was in shock when he left the operating room. Two days later he became much distended, began to complain of abdominal pain and vomited. The chemical findings in the blood at this time are shown in the table. A duodenal tube was passed, the stomach was washed out, an enema was given and 1,000 cubic centimeters of 5 per cent sodium chloride and 10 per cent glucose were given daily. The patient's condition improved and he was started on small amounts of water by mouth. He later developed a huge extraperitoneal abscess in the right iliac region which was opened on February 23. At this time the bullet was located. The crest of the ilium had been fractured and there was a huge abscess present which later had broken into the peritoneal cavity. This was drained. The day following this operation the patient's abdominal wound broke down and his intestines came out on the abdominal wall. This was repaired immediately but the patient was in a very bad condition. A liter of intravenous solution was given daily for the next 2 days and a duodenal tube was passed siphoning off a large amount of brownish material. The patient's condition grew gradually worse and he died the following day, February 25. A chemical analysis of the blood shortly before his death showed it to be normal.

**CASE 16.** A white male aged 60 was admitted to the University Hospital on March 1, 1927, with a diagnosis of generalized peritonitis of several days duration. He had had bronchitis for several days previous to his abdominal symptoms. At operation a generalized peritonitis was found and a large amount of pus was removed from the abdomen. Much fibrin was present. Cultures were made which grew staphylococcus and pneumococcus. There was no real pathology to account for the generalized peritonitis; therefore the operative diagnosis was a pneumococcus peritonitis. A few days following the operation a paralytic ileus developed and the patient began vomiting. Intravenous medication was begun, 5 per cent sodium chloride and 10 per cent glucose being used twice daily for 3 days. The stomach was washed out and enemas were given. The patient's condition improved. The following day 2 per cent sodium chloride and 10 per cent glucose were given



a liter a day for days. The patient's condition seemed so much improved that further intravenous medication was stopped. Eleven days following operation he developed pneumonia and 7 or 8 days later an empyema from which were aspirated 700 cubic centimeters of foul smelling watery material containing bacillus coli. A few days later the chest was again aspirated and pus was withdrawn. Thoracotomy was now performed and the patient lived only 48 hours before dying from a terminal bronchopneumonia.

#### SUMMARY

Fifty-two cases of conditions with a low blood chloride are reported. Most of these are associated with abdominal conditions. These occurred in less than a year's time in a relatively small hospital. This high frequency indicates that this form of toxemia is much more common than is generally realized and is probably being overlooked in many institutions.

A fall in the blood chlorides in such cases below 60 milligrams per 100 cubic centimeters is accompanied by a distinct rise in mortality if untreated.

3 Clinical indications for the ordering of the necessary blood chemical tests by the physician are given.

4 Proper treatment of the patient along metabolic lines in many cases lowers the mortality and makes the individual a better risk for operation.

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THE CHOKED LABYRINTH AND ITS IMPORTANCE FOR DIAGNOSIS AND INDICATIONS IN BRAIN TUMOR<sup>1</sup>

BY PROF. DR. GUSTAV ALEXANDER VIENNA AUSTRIA

IF FROM the diagnostic standpoint one wishes to conceive fully a disease beyond the anatomical borders of the organ of hearing the symptoms must be classified into the following groups (1) symptoms as revealed by endoscopy together with disturbances of function of the ear (2) mastoidal symptoms (3) cerebral symptoms and (4) general symptoms

The examination of the patient must be adapted to such grouping. The diagnostic importance of the ear examination is characterized by the fact that two of these four groups concern the ear. We may say that our diagnostic and therapeutic success with intracranial otogenous diseases is due to this systematic arrangement of the examination and that on the basis of the complete consideration of such symptomatology the diagnosis follows as a natural sequence.

By degrees it has been found that a whole series of ear findings may be considered characteristic of certain intracranial changes. If the cerebral and general symptoms in a case point to an otogenous complication the ear findings alone may help us to localize to a certain degree the complication in the cranial cavity. When otology became of importance in neurological surgery it became necessary not only to study exactly the findings of the ear but to broaden our knowledge beyond the dominion proper of otology into neurology. However the diagnostic importance of ear findings is recognized when one can localize intracranial disease by means of them in conjunction with the cerebral and general symptoms. Thus sinus phlebitis is indicated by the sudden cessation of ear suppuration. Suppuration of the attic suggests an abscess of the temporal lobe, suppuration of the antrum with retention suggests a para otitis interna and hypotympanic suppuration especially with hypotympanic cholesteroloma suggests a bulbus phlebitis and a bulbus thrombosis. Postmastoidal pain indicates a perisinous

abscess and labyrinthine suppuration suggests a cerebellar abscess. Of course we cannot diagnose such intracranial diseases by means of the ear findings alone but they give us a reliable indication to the proper diagnosis.

In all of the examples mentioned the affection of the ear indicates the primary disease and the intracranial complication will indicate the secondary disease viz the intracranial symptoms are subordinate to the ear symptoms.

Notwithstanding the above conditions it may be that the ear findings and the cerebral complex of symptoms are co ordinate to each other since we find the same symptoms with abscess of the temporal lobe as with a gumma or with a tubercle of the temporal lobe or with a cerebral hemorrhage in the temporal lobe. In such cases the ear findings are suggestive of an abscess. The findings of a florid ear suppuration together with cerebral symptoms which point to the temporal lobe will indicate an abscess of the temporal lobe rather than some other anatomical change. Also under such circumstances the ear findings will support us in answering the following questions:

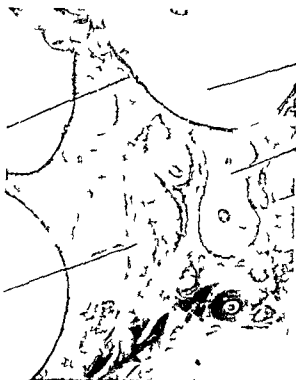
1. Is there an otogenous intracranial suppuration or an anatomical change?

2. In what part of the intracranial cavity are the changes localized?

Quite different are the premises with cerebral neoplasms for there irrespective of the cases in which an acoustic nerve tumor begins to grow in the depth of the auditory canal the cerebral disease will represent the primary change and the affection of the ear will represent the secondary change. In such instances the ear disease is subordinate to the cerebral disease. If otology is to do service in the diagnosis of brain lesions and aid in determining surgical indication we must endeavor to find out with what frequency certain neoplasms of the brain are associated with characteristic changes in the ear so that no matter whether



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 Cl k l l l y th A m j l l p l l t l t  
 th r t e m p l l A t h f th m j l l  
 W l k r a d q l t m t l ampulla l l K l l t k



l l m f th p t l l l N t p t e d p  
 Cl k l l l th l l t n l t r l t n th h  
 p l l l l p l th l p h t  
 l l f th m d l l th l e f th h

clinical brain symptoms have been ascertained or not the ear findings will enable us (1) to decide whether or not there is a cerebral disease (2) to decide whether the changes are functional or organic and (3) to ascertain the seat of the cerebral affection.

The ear findings, however, can attain such high importance in the diagnosis of the brain neoplasms only if in the first place it is proved that the ear shows changes in a considerable percentage of brain neoplasms and second if it is proved that the changes of the ear are characteristic for cerebral neoplasms of certain localization. J. Fischer studied the questions by the clinical and anatomical examination of a large number of brain neoplasms in numerous instances he repeatedly and at regular intervals examined certain cases. We have the ear findings in a number of cases

Th l l t d h p r w p p d l y D J F s ch  
 f s

before and after a brain operation. In some of these the neoplasm was exposed and removed surgically and in others we had to satisfy ourselves with a pressure relieving operation.

It would be wrong to assume that all aural change belong to the syndrome of the choked ear although we cannot deny that a brain neoplasm of any localization may be the cause of a choked labyrinth. However the closer topographically the brain neoplasm is to the ear and more particularly so to the inner ear the more directly may the changes of the ear develop as the neoplasm itself may involve the eighth cranial nerve and the labyrinth or the pathologic anatomical change in the neoplasm itself (hemorrhage, degeneration, cyst formation, proliferation of the connective tissue, etc.) may extend into the labyrinth. Under such circumstances it will be difficult even impossible to separate the consequences



FIG. 3. Tumor of the upper region of the parietal lobe. Not operated upon. Choked labyrinth. Blood and exudate in the cochlear aqueduct. *tc*.

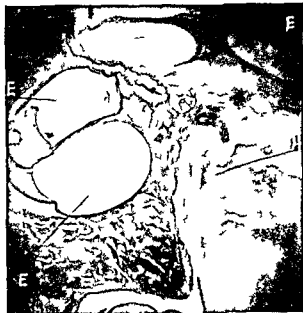


FIG. 4. Tumor of the middle fossa. Not operated upon. Choked labyrinth. Hemorrhage in the internal auditory meatus. *h*. Exudate in the scala *e* and in the cochlear canal. *Dc*.

of obstruction from the other changes. However it is the object of this paper to try to prove the possible presence of a choked ear.

For such a purpose the most suitable case of cerebral neoplasm is the one the farthest from the ear. The method of discovering the choked ear by clinical examination must consist therefore in ascertaining the changes of the ear which occur with neoplasms found within the anterior and middle cranial fossae. Only with such experience may we undertake to learn the components of the choked ear in the presence of such affections as cerebello pontile angle and acoustic nerve tumors.

Before going into the discussion of this group I should like to give a short report on the anamnestic symptoms of the choked ear to be found during the examination of the ear and upon the necessary extent and course of such an examination.

What are the symptoms of the choked ear? In the history of the case we may learn that deafness has developed slowly, often with remissions at first to temporary normal hearing. Deafness usually shows however a distinct progression whereas acute deteriorations are seldom found. Such symptoms present a great contrast to the changes of the ear appearing with tumors of the acoustic nerve which are characterized by rapidly occurring permanent deafness. Subjective noises are common in almost all cases and in a majority of them a high sound is heard.

Examination shows a labyrinthine affection which cannot always be differentiated from other labyrinthine affections. Thus the upper limit of hearing is strongly diminished while the lower limit of hearing is not greatly diminished. There are also cases in which with comparatively little diminished acuteness of hearing the conduction of sound by the cranial bones is strongly reduced. Such peculiar findings may also be present with lentic labyrinthine affections and with injuries of the head. Habermann found reduced conduction of sound by cranial bones for low tones and Cridenigo reports a considerable increase of electric irritability of the cochlea, but Fischer was unable to confirm these findings.

The labyrinthine symptoms consist of spontaneous nystagmus, vertigo, reduced sense of equilibrium, changes of the labyrinthine reflex excitability and in addition thereto wrong pointing in the pointing test, abnormal and atypical falling reactions, disturbances of the eye muscles and disturbance of muscle tone reactions.

We often meet with vertigo in the anamnesis of brain tumors of the anterior and middle cranial fossae. This however is usually of slight degree. The attack is not fully developed and the patient therefore cannot state



(Brunner Babinski) and laterotractor (Brunner) disturbed sensibility and a disagreeable perception of smell and taste

4 Objective symptoms during the vertigo inability to walk in the direction of subjective rotation (the patient in the state of vertigo moves in the opposite direction to that of rotation) The patient will stand facing opposite to the direction of apparent rotation he will incline the axis of his body in opposition to the axis of rotation and he will look for a place to lie down endeavoring with all possible muscular exertion to get hold of solid objects in order to protect himself from injury by centrifugal action

5 Subjective symptoms after the attack of vertigo There are no symptoms after a slight attack of vertigo but after more severe or longer attacks there is numbness and a tired feeling However there is no disturbance of consciousness and in the case of labyrinthine vertigo (contrary to other types) the patient

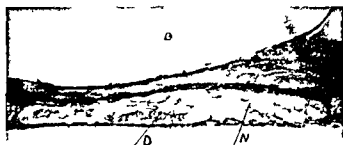


Fig 8 Tumor of the parietal lobe Not operated upon Choked labyrinth Lamina spiralis ossea of the basal turn of the cochlea Atrophy of the cochlear nerve Ac Diameter of the blood vessels

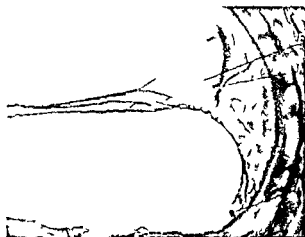
himself is able to report all the details of the attack and its symptoms including the aura and duration of the attack After a more severe vertigo there is a sense of nausea and apparent rotation An apparent movement of the surroundings may still be observed to a slight degree after the attack although in the opposite direction

6 Objective symptoms after the attack of vertigo of a slight degree consist in more or less distinct disturbance of equilibrium and temporary disturbance of gait after violent attacks we note convulsions clonic spasms and vomiting In the case of labyrinthine vertigo vomiting always occurs at the end of the attack and is a symptom of severe vertigo Rotary vertigo during an attack may be accompanied by tactile vertigo However the latter may exist without the former Tactile vertigo has been thoroughly investigated by Brunner He distinguishes (1) tactile vertigo with delusions on the location of objects within the tactile area and (2) tactile vertigo with delusions as to location of the patient's own body In the latter group he also includes lateropulsion It is a striking fact that rotary vertigo is frequently a symptom in cases of frontal brain tumor However there are also cases of tumor of the middle cranial fossa with rotary vertigo

Spontaneous nystagmus is a typical symptom of brain tumors which produce the choked ear Intracranial pressure as a whole may cause spontaneous nystagmus centrally In such cases the spontaneous nystagmus only indicates the intracranial disease as such In connection however with the functional tests of the peripheral ear and the cerebellum the



Fig 7 Tumor of the middle fossa Not operated upon Choked labyrinth Passive hyperemia of the inner ear Atrophy of the cochlear nerve Ac and of the organ of Corti exudate in the cochlear aqueduct Ac



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detail because he does not notice them. He will often speak of an uncertain sense of vertigo of motor uncertainty numbness, etc. In vertigo produced by turning in the majority of cases the apparent rotation is projected to the surroundings of the patient. It follows the direction of the quick component of the spontaneous nystagmus whereas the reaction movements of the patient follow the direction of the slow component. By looking in the direction of the quick component the degree of vertigo will be increased. A detailed description of the vertigo found with the choked ear would be a repetition of that given for vertigo in labyrinthine disease.

We must know the details of labyrinthine vertigo thoroughly for if the patient has only rare attacks we will not be able to see them and note the objective phenomena. By means of experimentally produced vertigo otology has made us acquainted with the missing details. In experimental vertigo we are able to observe all of the detail which characterize weak, medium and strong labyrinthine vertigo. Then by comparing the symptoms that were found in experimental vertigo with those symptoms reported by the patient we will be able to say exactly whether the patient is suffering from a slight or from a severe vertigo without having actually seen the patient in an attack.

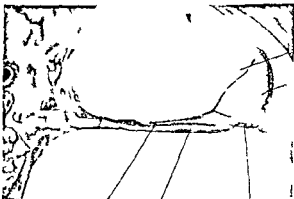
In every case of vertigo we must separate the patient's subjective and objective symp-

toms. In experimental vertigo the symptoms must be divided into four groups: subjective and objective symptoms during and after attacks of vertigo. Two additional groups must be added in vertigo occurring as the result of a pathological process inasmuch as an aura is usually present. These include the subjective and objective symptoms of vertigo which occur during the aura. It is necessary therefore to group all of the anamnestic statements made by the patient about his vertigo within the aura group.

1. Subjective symptoms which occur during the aura before an attack: psychic and motor exhaustion, loss of appetite, sudden change of increase or decrease in acuity of hearing, and acute change of the subjective noise. Such noise in the ear may disappear before the attack of vertigo or if there were no such noise they may appear as a preliminary symptom of vertigo (more particularly so with a motor vertigo of the labyrinth) or finally such noise may be increased to an enormous degree as howling and roaring (with arterio-sclerotic vertigo).

Objective symptoms of the aura pale nose in other cases hectic redness of the cheeks, hollow eye sockets, lack of deportment, tired or hanging gut and a dislike of walking.

3. Subjective symptoms with the attack of vertigo: apparent rotation of the patient's surroundings or of his own body, changed location of the objects of the surroundings or the floor (vertigo by touch), lateropulsion



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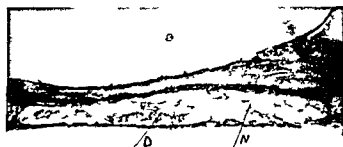


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spontaneous nystagmus may also be of great value in the localization of the intracranial tumor. For this purpose however all detail of the spontaneous nystagmus must be considered. Only one who has the skill and experience to observe exactly the eight points of spontaneous nystagmus which I emphasized years ago will be able to utilize it as a diagnostic and valuable symptom in the way of localization. The eight points that have to be established in considering spontaneous nystagmus are the following:

1. The association or dissociation of the spontaneous nystagmus viz whether or not it is constant in regard to direction, amplitude, frequency and intensity.

The direction to the right to the left upward and oblique.

2. Form of motion rotating, straight, combined.

3. The velocity measured by the number of nystagmic stroke in the time unit (more than 100 strokes rapid, 40 to 100 stroke medium, under 40 stroke slow).

Amplitude—coarse, medium and small strokes.

4. Intensity—low, medium and highest degree of intensity according to Alexander. In the slightest degree the spontaneous nystagmus is visible only when looking in the direction of the quick components in the medium degree the nystagmus is still visible when looking straight ahead in the highest degree of intensity the nystagmus remains visible when looking to the other side viz toward the slow component hence it is independent of the direction in which one looks.

5. The duration of the nystagmus. When spontaneous nystagmus is observed for a longer time it may either (a) remain the same, (b) disappear periodically or (c) be more pronounced gradually especially by repeatedly turning to the side.

6. The readings of the nystagmus which also includes the motor nystagmus mentioned by Brunner.

If we consider the details of spontaneous nystagmus they may help to determine a fundamental localization of the pathology.

First of all we know that a violent spontaneous nystagmus may be caused only by acute

severe changes of the peripheral labyrinth (injuries and foudroyant suppuration) and that even under such circumstances the severity of the symptoms together with the spontaneous nystagmus has usually diminished by the end of the first week. The maximum type of spontaneous nystagmus on account of its duration alone will allow us to conclude that it is due to a central disease. An extended straight nystagmus indicates central change near the nucleus of von Bechterew while a straight and vertical nystagmus points to a change within the reach of the posterior longitudinal bundle. Spontaneous nystagmus however as a clinical symptom will have full significance only in connection with the labyrinthine reflex excitability.

The proper examination of the labyrinthine reflex excitability consists of four different examinations: the rotation, caloric, mechanical and galvanic excitability tests.

Examination in the rotary chair reveals the mobility of the labyrinthine epithelium; the caloric examination reveals the moving and flowing capacity of the endolymph; the mechanical examination reveals the condition of the labyrinthine cupule and the galvanic examination reveals the condition of the nerve of the peripheral labyrinth.

For years our effort have been to go from the originally applied maximal excitability to the minimal excitability. This was fully attained by Kobrak's method of minimal excitability and by Kobrak's conception of the cause of production of the nystagmus. Thus we have attained an exact foundation for examining the labyrinthine overexcitability, the very important condition in the diagnosis of brain tumors.

When examining the labyrinth in the case of brain tumor Fischer maintains that a certain peak of a pathological reflex excitability only if there is also a spontaneous nystagmus at the same time. Thus he found the labyrinthine reflex excitability changed pathologically in 14 of 44 cases of cerebral tumor. Five other cases in which the examination of the external ear showed pathological change but no spontaneous nystagmus he classified among the normal case in regard to labyrinthine reflex excitability.

As to the important details of his cases Fischer reports the following 'In most of the cases we have to deal with an increased excitability inasmuch as both the latency is shortened and the nystagmus lengthened (7 of 9 cases). The overexcitability in almost all cases refers to both sides so that this symptom is of no importance in localization and can be considered only as the expression of increased intracranial pressure—a symptom of obstruction. If the increase of pressure in the skull cavity becomes intensive very rapidly or if such increased pressure is observed for some time the initial overexcitability of the labyrinthine reflex excitability may gradually diminish. This is analogous to the other reflexes which will increase as long as the condition of irritation persists whereas with paralysis they will diminish or disappear. In my material of 9 cases having a pathologically changed irritability I could observe only cases with irritability below the normal. The one case was a frontal lobe tumor which at the beginning produced an overexcitability of both labyrinths and only repeated otological investigations showed an excitability below the normal. The other case was an endothelioma of the dura which had compressed the greater part of the temporal lobe and which was accompanied by a proliferation of the tumor substance into the petrous bone. I could in this case establish clinically an excitability of the affected side below the normal and an overexcitability of the contralateral side. Serial sections made through the ear in this case did not show any changes in the nervous labyrinthicus nor in the ganglion nor in the terminal places whereas the spaces of the middle ear were filled with tumor substance and the tympanic membrane was considerably thickened as a result of the tumor infiltration. In discussing the histological findings of these cases I stated that the tumor masses had rendered difficult the conduct of irritation and that this fact was the cause of the underexcitability and more particularly of the very much prolonged latent period.

Examination in the rotary chair will sometimes give valuable information about the choked ear. Reflex excitability may thus be maintained with no caloric excitability or

reflex excitability may be absent whereas caloric excitability is maintained.

In the presence of increased intracranial pressure the sensation after turning may be disturbed (Fischer). Lagleton under such circumstances found reduced excitability of the reflex within the sphere of the vertical semicircular canals. In neoplasms within the posterior cranial fossa the greatly increased intracranial pressure places the labyrinth entirely out of function. Especially with the circumscribed subdural or arachnoid accumulation of fluid upon the anterior surface of the cerebellum and the brainstem the reflex excitability upon rotation may be greatly diminished. In general we must be very careful in examining in the rotary chair patients who are suffering from a brain disease. Too vigorous turning may have serious consequences.

Spontaneous past pointing is known to be a characteristic symptom of neoplasms of the cerebellum. However Fischer found spontaneous past pointing in 4 of 44 cases of brain neoplasms of the anterior and middle cranial fossa and in 3 other cases found an atypical pointing reaction. He could not decide whether or not in these cases he had to deal with a distant lesion of the cerebellum. Nevertheless it is established that spontaneous past pointing does not come within the scope of choked labyrinth.

In only cases of 44 Fischer found an atypical falling reaction. The tonus reaction of the arm according to which the sensation of gravity of both sides of the body is subjectively changed due to labyrinthine irritation is of no practical importance for the diagnostic examination of brain tumors.

When examining spontaneous nystagmus we must pay attention to any evident paralysis of the eye muscles as this often occurs with increased intracranial pressure more particularly on the rectus externus. In such cases the eye with the labyrinthine reflex will make stronger strokes in the direction of the paretic muscle than the unaffected eye thus simulating a dissociated nystagmus. In all cases in which paralysis of the eye muscles is caused by a lesion of the nucleus the eye upon the paralyzed side will lag behind in the caloric test and thus the stroke of the healthy eye

will be stronger. If on the other hand the disturbance of the eye muscles is due to a lesion in the peripheral portion of the nerve the nystagmus will be associated with irritation of the labyrinth.

Of further clinical importance is the paralysis of conjugate movements of the eyes. Fischer mentions groups the horizontal and the vertical. Paralysis of conjugate movements of the eye to either side may be caused by a disturbance in the pons or in the cortex. The pathology in a case of paralysis of conjugate movement to either side due to a cortical lesion is always found at the base of the second frontal convolution in the gyrus angularis or about the fissura calcarina of the occipital lobe. In the case of a brain tumor which exhibits restriction of horizontal ocular movements we must first ascertain whether or not we have to deal with a paralysis of conjugate movements or with a paralysis of the muscle itself. With pontile paralysis no experimental nystagmus will be produced in cases in which the labyrinthine reflex arc is equally interrupted. When the latter is injured through a tumor the quick component will disappear whereas the slow component will persist.

Thus Barany could produce by rotation only the slow component of nystagmus in a patient with a paralysis of conjugate movements. In this case at the climax of the disease movement of the eyes could not be produced in any other way than by vestibular irritation. Autopsy revealed a leukotic infiltration of the corpora quadrigemina down to the pons. On this principle that spontaneous and reflexly produced nystagmus were lacking, Barany assumed that the motor tract for eye movements was destroyed at the level of the visual centers or between the latter and the nuclear region. On account of the irritability of the labyrinth it was out of the question to determine whether the nucleus was fully or almost fully intact whereas in paralysis of horizontal conjugate movements the distinction between cortical and pontile lesions may be discussed. Such differential diagnosis does not come into consideration in paralysis of vertical conjugate movements because we do not know of any area in the cerebral cortex

which when destroyed will produce such a paralysis. Therefore we can conclude that this symptom is of great localizing value in tumors of the midbrain. In such cases there usually is a spontaneous nystagmus in the opposite direction hence with paralysis of conjugate movements of the eyes upward a downward vertical nystagmus and vice versa will be present.

If the tumor reaches further caudad for instance into the region of the nuclei of the eye muscle or into the fasciculus longitudinal posterior then a combination of paralysis of the vertical and horizontal conjugate movements may be present. In such a case the quick component of the nystagmus will be missing when the labyrinth is being examined.

The care of all of the ear symptoms which are observed in case of brain neoplasm and we must now inquire how much the individual findings change characteristically if we group the neoplasms according to their location. Such is the case of the anterior posterior and middle cranial fossa. It goes without saying that the changes in the ear will be more developed typical and frequent the nearer the tumor is to the ear. However if we wish to study the choked ear we must exclude all cases in which the ear was attacked by the neoplasm directly either—as in the case with many eighth nerve neoplasms—by the growth of the tumor into the depth of the inner ear or—as is the case with tumors of the cerebellum and cerebellopontile angle—by the spreading of the neoplasm from the brain into the ear. Of course in such case there are signs of congestion in the inner ear but only after having sufficiently established clinically and anatomically the picture of the choked ear are we able to differentiate the character of the ear caused by obstruction from the other changes of the ear due to direct extension of the neoplasm into the ear. In the first place we must investigate such changes of the ear that have been directly caused by the brain neoplasm and for such an investigation the most suitable cases will be those in which the neoplasm is farthest from the inner auditory canal.

I wish to state the following with regard to changes of the ear associated with neoplasms

of the frontal lobes of the brain the midbrain and finally the cerebellum and the brainstem excluding the cases of direct extension of the neoplasm into the ear

In neoplasms of the anterior and middle cranial fossa Fischer found ear changes in 77 per cent of 44 cases in 60 per cent of all cases the cochlea was disturbed and in the majority of cases the disturbance was on either side In 9 cases the cochlear affection showed a distinct progression The labyrinth was disturbed in 60 per cent of the cases often with overexcitability and more rarely with under excitability In 4 cases there was violent spontaneous nystagmus without vertigo and in 4 cases there was spontaneous past pointing

#### I NEOPLASMS OF THE FRONTAL LOBES OF THE BRAIN

We frequently find slight difficulty of hearing similar to that of the inner ear with decrease of the upper tone limit and insulate and sometimes varying cutaneous of hearing Among the labyrinthine symptoms the disturbances of equilibrium stand out most prominently Fischer has collected the early literature on this subject (Wernicke Moeli and Nothnagel) and has found that Bruns was the first to point out the similarity of disturbances of equilibrium which appeared with tumors of the frontal lobe to that appearing with the ataxia due to diseases of the cerebellum Bruns assumed that the frontal lobe had the importance of a static locomotor organ which was in function superior to the cerebellum

The anatomicophysiological foundations of frontal ataxia have been repeatedly investigated Bruns Anton Zingerle and Kleist assumed that the frontal brain constitutes a center for the voluntary motions serving to maintain the equilibrium and that the impulses coming from this center are conducted to the cerebellum as a co ordination center by way of the frontopontile cerebellar tracts According to Flechsig and others there exist fascicles of fibers extending from the frontal brain through the pons to the cerebellum Wernicke explains the frontal ataxia by a paralysis of the muscular apparatus of the trunk the centers of which are localized in

the frontal lobes He supports his assertion by the investigations of Munk and Meynert who attribute the strong development of the frontal brain in man and anthropoids to their upright position According to later investigations (Sherrington Vogt) such opinion has been refuted On the other hand many observers believe that ataxia present in frontal lobe tumors is caused by the intracranial pressure exerted on the cerebellum and the brainstem If such is the case homolateral disturbances of co ordination should be proved with frontal ataxia in the same way as with cerebellar ataxia since we do not have to deal with bilateral extension of the neoplasms Ataxia is an essential symptom for the localization of tumor of the frontal lobe Fischer found tumors in 9 of 44 cases of cerebral disturbed equilibrium In 8 of these 9 cases there was a neoplasm of the frontal brain One patient had a tumor of the corpora quadrigemina If besides disturbances of equilibrium there are still other symptoms referable to the ear the differential diagnosis between a neoplasm of the frontal lobe and the cerebellum may become very difficult In the end we must always distinguish frontal ataxia from cerebellar ataxia Bilateral disturbance of co ordination of the same degree will speak for frontal lobe ataxia Homolateral or at least bilateral disturbance of co ordination not of the same degree speak for cerebellar ataxia Moreover normal acuteness of hearing normal labyrinthine excitability and no spontaneous nystagmus speak for frontal ataxia and against cerebellar ataxia In general impaired hearing and labyrinthine overexcitability point to a neoplasm of the posterior cranial fossa Fischer however recently saw 3 cases in which such symptoms were found with a frontal brain neoplasm Spontaneous past pointing which Karlsfors says appears with cerebral neoplasms may be explained by the pressure exerted on the cerebellum It is clinically characterized by alternating spontaneous past pointing or by the appearance of a weaker pointing reaction with one or both extremities to the outside and a stronger reaction to the inside

In cerebral neoplasms there should be cerebral past pointing whereas other cerebellar

symptoms are missing. In 3 of his recent cases of frontal brain neoplasm Fischer did not find any cerebral past pointing, and to him it is not surprising since he has already proved by his investigations that spontaneous past pointing may even be missing with cerebellar neoplasms. Warburg has demonstrated cerebellar ataxia as the summary of 3 groups of disturbances:

1. Disturbance of innervation (dysmetria hypermetria). Such disturbance is tested by means of the finger to nose test, finger to finger test, knee to heel test, by walking on a line and by walking with one leg crossed in front of the other.

2. Disturbed continuity of muscular contraction—ataxia. The disturbances are characterized by insecurity, shaking, staggering and even falling.

3. Disturbances in the order of motions—asynergia—characterized by the staying behind of the trunk when the patient walks ahead. The same thing is observed when the patient wishes to sit up from a lying position. He will then raise his legs unnecessarily high from the bed.

Normal acuteness of hearing, or slight unilateral or bilateral or varying decrease of hearing speaks for an affection of the frontal brain. There is no spontaneous nystagmus or but a slight one with frontal brain neoplasms, whereas a marked coruscant and straight nystagmus of high intensity is found with affection of the posterior cranial fossa. With frontal lobe processes there is usually slight spontaneous inclination to fall without any characteristic localization, while with diseases of the cerebellum there is always an inclination to fall in a certain direction. With affections of the vermiciform process and the middle lobe of the cerebellum the patient is inclined to fall backward or forward. Violent characteristic attacks of labyrinthine vertigo as rotary or tactile vertigo with spasms, vomiting, etc., from the onset of brain symptoms indicate an infection near the posterior cranial fossa, whereas slight vertigo indicates an affection of the frontal brain. An early appearance of a choked disc with severe visual disturbances speaks for an affection in the posterior cranial fossa.

## 2. NEOPLASMS OF THE PARIETAL LOBE AND THE INTERNAL CAPSULE

Fischer was able to show quite clearly that in these cases the ear symptoms depend upon the other signs of obstruction. Among 10 parietal brain neoplasms he found the ear to be normal in 3 cases with no symptoms of obstruction. On the other hand he ascertained that particularly in the case of parietal brain neoplasms the ear symptoms appeared and grew clearly stronger as the intracranial pressure increased. Such ear symptoms were manifested by reduction in hearing ability, shortened conduction of sound by the cranial bones, reduced upper limit of sound and spontaneous nystagmus. With neoplasm of the parietal lobe there are sometime disturbances of the sense of touch and position. Disturbed hearing may be the consequence of obstruction or it may be a localized symptom with extension of the neoplasm to the auditory cortex of the temporal lobe. Deafness of cortical origin always involves both sides and is usually only slight. Unilateral deafness, therefore, speaks for symptoms of obstruction in the peripheral organ. If deafness signifies a localized symptom there are usually no symptoms of labyrinthine excitability or defect of the labyrinth.

## 3. NEOPLASMS OF THE OCCIPITAL LOBE

Here symptoms of labyrinthine excitability will appear more frequently than those of cochlear excitability of the neoplasm on the cerebellum. With no intracranial pressure the ear is found to be normal. In neoplasm of the occipital lobe change in the eye is of course much more valuable as localization and than are change in the ears. The labyrinthine reflex excitability does not help in the diagnosis since overexcitability and underexcitability of the labyrinth may appear either with general intracranial pressure or with disturbance in the neighborhood of the cerebellar fibers.

Eagleton asserts that increased intracranial pressure lead to a decreased excitability of the vertical semicircular canal. It may be entirely excluded with localization in the posterior cranial fossa. This symptom is certainly a general one and does not permit of

accurate localization. According to Eagleton an accumulation of cerebrospinal fluid above the portion of the anterior surface on the cerebellum which is opposite to that of the posterior surface of the petrous portion of the temporal lobe produces the following symptoms: diminished duration of the turning nystagmus; exclusion of both vertical semicircular canals; and spontaneous past pointing. Later on the spontaneous past pointing will disappear. By means of labyrinthine irritation, however, it will not be possible to produce past pointing in the direction opposite to that of the former spontaneous past pointing. Accumulation of exudate in the arachnoid meshes above the cerebellum diminishes the duration of the rotary nystagmus by half. Stenvers reports the forced holding of the head with brain tumors above and below the tentorium. This he attributes to mechanical factors caused by disturbed outflow of the exudate. If the tumor is above the tentorium the patient will bend his head backward in order to facilitate the outflow from the third into the fourth ventricle. With tumors of the posterior cranial fossa the patient will hold his head forward in order to widen the communication between the fourth ventricle and the cisterna magna and also to widen the cisterna itself and to free the oblongata from pressure. Such forced holding cannot be corrected by cerebral innervation.

#### 4. NEOPLASMS OF THE POSTERIOR FOSSA

##### A. TUMORS OF THE CEREBELLOPONTILE ANGLE

*a. Nervus acusticus tumors.* Fischer found homolateral deafness and also in a considerable number of cases deafness of the inner ear of the opposite side of which the patient knew nothing subjectively. In 44 per cent the labyrinth was not excitable on the side of the neoplasm. Depending upon the position or size of the neoplasm both labyrinths may be unexcitable and both sides deaf. In 1 case Fischer found inexcitability by rotation on the contralateral side and in another case overexcitability on the contralateral side with inexcitability on the homolateral side and a nystagmus for 6 minutes after the caloric test. He found spontaneous nystagmus in 55

per cent of the acoustic tumors and spontaneous past pointing 8 times in 7 cases of which 3 showed spontaneous past pointing of the homolateral extremity toward the side of localization whereas the other extremity pointed correctly.

*b. Tumors of the cerebellopontile angle excluding the acoustic nerve tumors.* The ear symptoms depend upon the seat of the neoplasm and in the majority of cases there is homolateral deafness and homolateral inexcitability and underexcitability.

*c. Neoplasms of the pons and the medulla oblongata.* Fischer found in some cases deafness and inexcitability on the affected side. However there are also cases of overexcitability with deafness or normal hearing.

With hydrops of the recessus lateralis the spontaneous nystagmus may occur in attacks varying with the position of the head.

#### B. NEOPLASMS OF THE CEREBELLUM

In about 50 per cent of the cases there is an affection of the inner ear and sometimes deafness. Spontaneous past pointing is not often found. Fischer found such past pointing in 2 out of 16 cases. At the same time there may exist labyrinthine overexcitability and sometimes forced holding of the head. In some cases there is no pointing reaction after experimental irritation of the labyrinth. There may be atypical falling direction after the caloric test.

#### COURSE AND PROGNOSIS

With early operation of the brain tumor many changes of the labyrinth may return to normal such as hyperemia and also formative changes without disturbance of function of the inner ear. If however the choked labyrinth has persisted for some time no healing with *restitutio ad integrum* is to be expected. The lost auditory cells cannot be restituted and the dilatations, agglutinations etc represent permanent changes. If during the process of the choked labyrinth permanent changes of the inner auditory canal and the aqueducts have developed then after the exclusion of the causative brain disease the affection of the inner ear may continue and develop into degenerative atrophy of the nerve.

endings and the nerves of the labyrinth. We shall meet with the same unfavorable prognosis in all cases in which during obstruction endolymphatic hemorrhages and endolymphatic exudations have developed. In case of decompression brain operations we must take into consideration the danger of hemorrhage within the region of the labyrinth especially in the endolymphatic portion and with the region of the internal auditory canal.

### DIAGNOSIS OF THE CHOKED EAR

According to Luch, in 90 per cent of the brain neoplasms the choked disc of the optic nerves could be found. Habermann describes the choked ear from the clinical viewpoint as increasing poor hearing of deep sound through the bones of the head with comparatively good hearing otherwise. From the pathologico-anatomical standpoint there are 3 groups: (1) venous hypertension and lymph stasis; (2) inflammation; and (3) degenerative atrophy. Lischer describes subjective noise, diminished hearing, shortened conduction of medium sound by the cranial bones, diminished upper limit of sound, etc. He found that in cerebral neoplasms the ear symptom appeared simultaneously with the change of the fundus oculi. In two cases the ear symptoms preceded those of the eye. Thus the ear findings are of great importance for the early diagnosis of the neoplasms of the anterior and middle cranial fossa. Of still greater importance, however, are the ear findings in the diagnosis of neoplasms of the posterior cranial fossa and acoustic nerve.

It is much more difficult to judge the choked labyrinth by the clinical ear finding in connection with brain tumors. Lischer studied this question with the tumor material at Lichberg's clinic. He found that in quite a considerable percentage of cases there were positive ear findings, whereas the percentage was far behind that of the choked disc in cases of tumors of the anterior and middle cranial fossa, and even among the positive ear findings there must be diseases which are not caused by obstruction but by inflammation—neuritis nervi octavi—or by the direct spreading of the tumor. To a great extent this is the case with changes of the ear due to tumors

of the posterior cranial fossa primarily at the angle of the cerebellum, pons and the eighth nerve itself. Here the direct degenerative changes and the spreading of the neoplasm to the eighth nerve are the main factors. Hence we may assume that the farther the tumor is from the inner auditory canal the greater will be the labyrinthine changes due to the obstruction only.

Lischer considers both the ear changes and the choked disc to be important early diagnostic symptom and of fundamental value in diagnosis. The ear findings may seldom be made use of in localization but still more frequently they are of value than the choked disc of the eye which permits a localization only in exceptional cases. In order to establish the value of ear findings for the local diagnosis of brain neoplasms Lischer has divided all cases under his observation into 3 groups:

1. Case in which the ear findings indicate the correct diagnosis.

2. Case in which the ear findings are inclined to give incorrect localization.

3. Case in which the ear findings are of no importance.

In 44 cases of cerebral neoplasms the ear findings together with other symptom helped to correct the diagnosis of 21 cases, viz. in 47.5 per cent, whereas in 5 cases, viz. 11 per cent, the ear findings influenced the diagnosis in a wrong direction and in 16 cases, viz. 41.5 per cent, the ear findings were of no significance from a localizing diagnostic standpoint. In certain cases the otologist could only state whether or not the neoplasm was in the anterior or the middle cranial fossa.

Among 7 cases of tumors of the acoustic nerve the ear finding helped correct the localization of the disease in 4 cases, viz. about 90 per cent. In 3 cases the ear findings were misleading. In 16 cases of cerebellar neoplasm the ear finding helped make the correct diagnosis in 9 cases. Only in exceptional cases will it be the otologist's task to make the diagnosis of neoplasm whereas in most cases the ear finding should either support or weaken the diagnosis placed by the neurologist.

From all the deliberations we arrive at the conclusion that the ear changes in neo-

plasms of the anterior and posterior cranial fossa are the result of obstruction some of which are capable of restitution and some of which will remain permanent. We must find out what constitutes these obstructural changes of the ear and how they come about. Unfortunately we cannot observe such change in the ear on the living patient while in cases of obstruction in the optic nerve we are able to make a rapid and unobjectionable examination. We must therefore examine histologically the ear of cases with fatal brain neoplasms and if possible we must take cases in which no brain operation was performed. Of particular value are all such cases in which the ear was exactly and repeatedly examined clinically. If we now summarize the anatomical ear findings of a greater number of such cases i.e. early cases and late cases we shall by degrees get a picture of all the anatomical changes which are possible with the choked ear. Here however we soon meet with a great obstacle since the early cases are not subject to autopsy whereas the late cases show only the maximum of ear changes. In order to ascertain the obstructural changes in the inner ear we may avail ourselves (a) of the well known histological changes in the choked eye (b) of experimental investigations and (c) of the anatomical ear findings of secondary labyrinthine affections of the different primary diseases besides the brain neoplasms in which because of the nature of the primary disease obstruction of the labyrinth is already rendered possible.

#### NORMAL ANATOMY

The correlation between the skull and the ear is such that all changes of the skull rapidly extend to the ear and on the other hand changes of the ear also will directly influence the skull cavity. Such ear changes are well known as intracranial otogenous diseases by their etiology occurrence and frequency. The changes in the skull causing secondary changes in the ear are however not so well known. Brunner would expect a difference in the changes and also in the reaction of the intracranial pressure upon the different anatomical structures of the optic nerve which is part of the central nervous system and of the acoustic

nerve which is a peripheral nerve. In opposition to this we must remember that especially with the labyrinthine nerve the glia (cortical) extends more to the periphery and on account of the channel like connections between the inner ear and the skull cavity the intracranial pressure will be conducted to the periphery of the labyrinth far better than it would be in the case of the eye.

Theoretical reflections on the occurrence of symptoms of choked labyrinth lead to different conclusion according to the initial view point. The comparatively close and direct connection between the labyrinth and the endocranium will make it likely that changes due to the intracranial pressure will be noticed quite readily in the labyrinth. We must consider that the inner auditory canal is considerably less filled by nerves which go through this canal than is the foramen opticum through which the nervus opticus passes. Especially in the fundus of the inner auditory canal within the reach of the ramified octavus we meet with wide fissures filled with cerebrospinal fluid which directly conduct the changes of pressure. The aqueductus cochleæ connects the scala tympani of the cochlea directly with the endodural space.

If we wish to prove the possibility of a choked ear we must discuss a series of questions in different ways. The most important of these are the following:

1. What theoretical premises offer to the normal anatomy the casual and the regular occurrence of obstructions in the labyrinth?

2. What conclusion may be derived from the physiology of the ear in regard to obstruction?

3. What pathologico anatomical findings offer an illustration for what we call a choked ear?

4. What clinical facts speak for the choked ear? It is to be understood that here we shall admit only such findings as have actually typical and frequent details.

#### THE NORMAL ANATOMICAL HYPOTHESIS FOR THE PRODUCTION OF THE CHOKED EAR

The labyrinth is directly connected with the skull by three channels two of which viz. the inner auditory canal and the aqueduct of



the cochlea end intradurally whereas the third one i.e. the aqueductus vestibuli ends extradurally. The inner auditory canal as far as it is not filled by the nervus acusticus facialis conducts the lymph stream which courses in and around this nerve through the little channels which run between the labyrinth and the inner auditory canal to the periphery of the inner ear. The aqueductus cochlear ends perilymphatically and the ductus endolymphaticus terminates endolymphatically. We thus see that the preformed normal channels which represent the connection between the skull cavity and the ear terminate both centrally and peripherally. Another question is that of permeability. Normally there remains enough of a fissure around the nervus acusticus in the inner auditory canal which is filled with cerebrospinal fluid and which ends however in the depth of the inner auditory canal. Its continuation toward the periphery does not consist of anything else but the sum of the microscopical lymph spaces which run along the nerve branches into the inner ear.

We must not however neglect the difference namely that the increased intracranial pressure and the obstruction have a more direct and stronger influence on the optic than on the acoustic nerve.

According to Karlefors the function of the aqueductus cochlear consists in the exchange of fluid between the brain space and the labyrinth. With adults in general it does not appear to let the fluid through quite so easily. The question may arise whether the stream flows from the labyrinth to the meningeal spaces or in the opposite direction. Karlefors assumes that the fluid in the aqueductus cochlear runs from the meningeal spaces into the inner ear.

According to such an hypothesis the channel would be the same as the pachymian granulations and the nerve sheaths would be a drainage for the subarachnoid space and thus would also provide the perilymphatic space with fluid. According to Fischer we may consider the anatomical changes of the ear in the same way as we do those of the eye in cases of increased intracranial pressure.

I cannot go into the theories of intracranial pressure in detail. Three groups of changes

have been considered which are the cause of intracranial pressure symptoms and which should also prove the cause of choked ear (a) the increased fluid pressure (b) disturbed circulation and (c) cerebral compression.

Different causes have been assumed for the choked disc and three different theories have been developed: the mechanical theory, the theory of inflammation and the neurotrophic theory. For the etiology of the choked ear we must moreover consider venous obstruction and compression of sinuses in the skull and the lability of the blood vascularization of the inner ear in which case—as Brunner supposes—previous vasomotor disturbances will create a locus minoris resistentie in the membranous labyrinth and in consequence whereof obstruction will develop more easily.

Emboli of the arteria auditiva interna may cause neuritis nervi octavi. Any disturbance in the circulation of blood in the labyrinth must cause a rapid change of pressure there since the capillaries here not only serve to nourish the tissue but the endolymph secretion takes place in the stria vascularis and the slightest disturbance in the latter must soon be noticeable in the labyrinth. This takes place more rapidly as the membranous labyrinth is covered by a rigid osseous tissue in which area change of pressure may be compensated only by the changed position of the stapes and the membrane of the fenestra rotunda. Labyrinthine hemorrhages may be considered as consequences of increased intracranial pressure as far as we have to deal with extensive and endolymphatic hemorrhages (Moos 1894, Panse 1906).

Sometimes the tumor formation within the reach of the cerebellopontile angle will lead to a widening of the inner auditory canal (also when the neoplasm itself had not been in the inner auditory canal) to a widening of the blood vessels in the inner auditory canal by obstruction analogous to the widening of the cerebellar and pontile vessels with such tumors as have been recently described by Nishikawa and to changes as with the choked disc of the eye. The walls of the widened vessels will often degenerate and with acute decompression may crack and thus cause hemorrhages in the inner auditory canal.

According to Hasse the overflow of the perilymph of the inner ear in the majority of cases of adults will take place in the inner auditory canal and only in a few cases in the aqueductus cochleæ. The permeability of the aqueductus cochleæ of the normal has been found only in children in whom it is empty and short whereas in adults it is long and narrow. Often in normal cases we shall find it narrowed and impermeable by connective tissue walls. Karlefors supposes the exchange of fluid between the endocranium and labyrinth to be in the aqueductus cochleæ although the latter in general is not easily permeable with adults.

The widening of the aqueductus cochleæ in a case of hydrocephalus (Habermann Alexander) may be considered rather as an inhibited development than the consequence of increased pressure. While it is true that the aqueductus vestibuli and the ductus endolymphaticus enclosed in the former terminate extradurally yet we must consider that the endolymphatic sac which contains the endolymph and is embedded in the dura is situated on the posterior surface of the petrous bone and thus with intracranial increase of pressure the contents of the sac must be pushed forward against the sacculus vestibuli. The aqueductus vestibuli conducts the ductus endolymphaticus and the space between the latter and the osseous wall is filled by connective tissue. However there are distinct and very fine accompanying lymph vessels which extend to the outside as far as the saccus endolymphaticus.

Finally we must say that the normal anatomical premises offered by the three channels mentioned are not alone sufficient to expect typical appearance and typical extension of changes.

In cases of pathological changes in the skull cavity in the ear and more particularly in intracranial pressure we shall however get a different impression if we consider the supply of blood vessels of the inner ear. Here the connection is established by the thin arteria auditiva interna which takes its course from the circle of Willis which is about 4 centimeters long has no branch and which resolves into terminal arteries. Already from the normal anatomical structure it may be

expected that even slightly disturbed circulation in the skull cavity must rapidly influence the supply of blood to the labyrinth both in regard to functional disturbances and organic changes. We must bear in mind that the arteria auditiva interna works like a feeler lever on the pressure and the disturbances of circulation of the skull and that its movements as they are otherwise registered on the kymograph are not expressed by a symptom complex of the inner ear.

Wittmack injected India ink into the subarachnoid space of a living cat and obtained the following result. Part of the substances injected into the subarachnoid space within a short time spread all over the subarachnoid space as a result of the osmotic differences. At the same time they get to the tissues of the subarachnoid space and its communications with the neighboring lymph tracts which mainly run along the tissue of the nerves. The aqueductus cochleæ also belongs to such communications so that these substances may enter through the former into the perilymphatic labyrinth space (Fischer).

Quincke by experiments on a dog found a direct connection between the subarachnoid space and the scala tympani.

As to the rest the results of experimental investigation are not unequivocal. Brunner by X ray experiments on young dogs produced an acute hydrocephalus internus which was followed by a considerable acute intracranial pressure. However he could not observe any clinical ear symptoms. The inner ear of a cat treated in the same way was normal from the histological standpoint. On the other hand Szasz experimentally succeeded in producing a vasomotor nystagmus with amyl nitrite. It is beyond any doubt that the intracranial excessive pressure leads to an increased pressure in the labyrinth whereas the regular appearance and the duration of changes still remain questionable.

It has not as yet been determined experimentally what the mechanical changes in the membranous labyrinth are which result from the intracranial increase of pressure. However the ear findings with meningitis point to the fact that depression of Reissner's membrane (Steinbrügge Gomperz Moos and

others) cannot be explained by the foregoing and must be explained rather as an artifact. Quix considers depression of the membrana vestibularis with acusticus tumors to be the consequence of perilymphatic excessive pressure due to intracranial increase of pressure; the latter besides may cause a vasomotor irritation of the labyrinth.

Of considerable importance is the disturbed lymph secretion of the inner ear which condition has been deduced from the histological picture by Rejto, Wittmarck and Zange. Wittmarck believes that hydrops of the inner ear results from a hypersecretion of the endolymphs in the stria vascularis. This assumption however is rejected by Brunner, Nagel and Gimplinger found serous exudate without any symptoms in the case of choked labyrinth. Labyrinthine hemorrhages following decompression operations on the skull have not as yet been observed.

The individual portions of the membranous labyrinth do not offer the same premise for reaction due to obstruction. The plan of the perilymphatic tissue leads us to expect that the membranous cochlea and the sacculus will strongly and rapidly react to change of pressure whereas the semicircular canals and the utriculus are more protected against pressure by perilymphatic septa (Burlett and Koster and Alexander). This discrepancy has been fully noted with regard to increased pressure coming from the middle ear and it illustrates the fundamental difference between the physiological action of the cochlea and the labyrinth. However pathological case also confirm our viewpoint since ectasies as a sequence of intracranial pressure change appear early and are frequently found within the vicinity of the pars inferior whereas they are very seldom seen in the pars superior and then only on the utriculus and not on the ampullae and the semicircular canals.

Choked ectasia may be followed by other changes such as venous hyperemia and lymph stasis and inflammatory and finally degenerative process with atrophy (Habermann) may possibly be combined with them from the very beginning.

The sensory cells in the cochlea as regards nutrition apparently depend entirely upon the

stria vascularis as the arteria auditiva interna remains intact. Thus Quix observed that the sensory cells of the labyrinth were intact in a case of acusticus tumor in spite of complete atrophy of the nerve stem.

In what way may the peripheral inner ear change on such an irritation? There may occur temporary and permanent change according to their localization change may be distinguished as follows: (1) in the nerve (2) in the nerve endings (3) in the walls of the membranous inner ear (4) in the perilymph and endolymph (5) in the perilymphatic tissue and the perilymphatic septa (6) in the labyrinthine capsule (7) in the labyrinthine windows and their obturating portions.

In general the labyrinth is more resistant to injury than the cochlea regardless as to whether they come from the periphery or from the skull cavity. Such a clinical experience is justified by two facts:

1. The resistance of a sense organ increases with the phylogenetic age. In the inner ear of man two apparatuses of very different phylogenetic age are united anatomically. The labyrinth goes through the entire series of animals down to the world of plants. In fact it is the primary sense organ. The cochlea on the other hand is an organ of hearing viz a sensory apparatus excitable by vibration coming from the exterior. It is first found in amphibians. The cochlear form viz the form of a round tube is shown rudimentarily in bird while the coil like cochlea is only found in mammals.

If we examine the size of the cell elements of which the nervous portions of the inner ear are composed we find that the sensory cells in the labyrinth are larger than those in the cochlea and that the cochlearis and the ganglion spirals are composed of very thin nerve fibers and very small ganglion cells. The nervus facialis shows the thickest nerve fiber and the largest ganglion cell all the way through whereas the labyrinthine nerve and its peripheral ganglia stand between the cochlearis and the facialis as to size.

Fischer himself has histologically examined 5 cases of tumors of the anterior and middle cranial fossa which have not been operated on and his findings in the inner ear are as follows:

- (1) exudative changes (2) passive hyperæmia
- (3) hæmorrhages (4) changes in the blood vessels of the inner ear (5) circumscribed obstruction (6) cellular infiltration and diapedesis (7) increase of the labyrinthine pigmentation (8) agglutination and adhesions in the region of the membranous labyrinth (9) formative changes of the membranous labyrinth (10) degenerative atrophies of the nerve ganglion apparatus and the nerve endings and (11) osseous degenerations

In the cases of choked ear in which the tumors of the anterior and middle cranial fossæ respectively were not operated on Fischer found a homogeneous faintly colored exudate with cellular contents. At times he found a fibriform exudate on the base of the Corti tunnel which I too have observed with chloromi of the cochlea. The quantity of exudate varies from the most minute circumscribed exudate in the scala and the vestibule (utricle) to a large pronounced exudate of clots in the perilymphatic and endolymphatic spaces with accumulation of exudate along the nerve sheaths in the tractus spiralis foraminosus in the medullary spaces in Havers' resorption spaces of the cochlear capsule and in the ligamentum spirale.

Hyperæmia is almost as frequent. We must however consider that an absolute unobjectionable proof of hyperæmia is very difficult. We find it in the cochlea in the form of a strong filling of the blood vessels in the medullary wall of the scala of the promontory vein of the auricle and of the lamina spiralis ossea. Also in the vessels of the stria vascularis there is frequently found a maximal filling of the strongly widened vessels which then project into the endolymphatic lumen like a ledge. There were similar findings in a case of luetic labyrinthine infection with individually acquired syphilis.

Fischer also refers to the constant occurrence of extravasation of blood in the labyrinth which may vary from a microscopical amount to that of considerable size. There often occurs a fresh hæmorrhage next to an old one. It is a question whether the increased pigmentation in the labyrinth which Habermann and myself have ascertained in cases of cerebral tumors and which I have also ob-

served with syphilis of the labyrinth is associated with the hæmorrhages. A considerable portion of increased pigmentation represents the increase of the normal perilymphatic labyrinthine pigment which does not come from the blood. Only in cases of luetic labyrinthine affection have I seen extensive pigment layers. Fischer has seen very small hæmorrhages between the layers of the lamina spiralis in the ductus endolymphaticus and in the sacculus. I myself saw such hæmorrhages in the ductus endolymphaticus and in the scala more particularly in the scala tympani and in the aquæductus cochlear. There may be extensive hæmorrhages in the inner auditory canal and in the scala septæ (Brunner Fischer).

Fischer refers to the histological symptoms of obstruction of the blood vessels in the inner auditory canal. The vessels are very much widened and around them is seen an abundance of blue or red stratified corpuscles and often a hyaline degeneration and a homogeneous exudate in the vessel.

As direct symptoms of obstruction besides venous hyperæmia of the labyrinth we must still consider the following homogenous transudate in the lymph spaces of the cochlear axis, the serous transudate in the ligamentum spirale and the œdema. In older cases a considerable connective tissue like thickening of the dural lining of the inner auditory canal may occur.

The most important formative change is represented by the ectasia of the entire pars inferior or part of the same—the cochlear, the sacculus of the ductus reuniens, the ductus and the sacculus endolymphaticus. Some years ago I discussed the causes which prevent an ectasia within the reach of the pars superior viz. the utriculus, the ampullæ and the semi-circular canals. In such cases we observe only diminutions in size of the lumina and this but rarely.

Decompression operations on the brain and skull cavity may cause traumatic hæmorrhages in the ear region and we can therefore consider such hæmorrhages as part of the symptoms of a choked ear only in cases that have not been operated upon. Degenerative atrophy involves the peripheral ganglia and the nerve endings. The sensory cells will remain more or less degenerated. The greater

part of the bone remains intact. The only changes that can be ascertained at all consist in the destruction of bone in the form of widened inner auditory canal with a circumscript atrophy and a formation of lacunæ.

When specifying the anatomical ear findings of a choked ear with different brain tumors we must also consider cases of cerebellar and acoustic nerve tumor. This group has already aroused the interest of the investigators and we shall therefore have more complete anatomical ear findings. Fischer has compiled from the literature the anatomical ear findings with brain pressure.

Based on histological investigation of even temporal bone, Habermann (1917) groups the changes in the labyrinth as follows:

1. Change of the nature of venous hyperemia in obstruction of the lymph vessels, smaller and more considerable fresh and old hemorrhage in the inner auditory canal and the labyrinth, abundance of pigmentation, destruction of Reissner membrane and the macula wall by excessive pressure of the perilymph and endolymph.

2. Change of an inflammatory nature. Inflammation of the perineurium in the inner auditory canal, infiltration of the cell between the nerve bundle, proliferation of the connective tissue.

3. Degenerative and atrophic change. Degeneration and atrophy of the nerve fibers and the ganglion cell of the nerve endings, atrophy of the bone, etc.

Fischer divides the ear change into three groups:

1. Extension of disturbed circulation (transudation, exudation, cellular infiltration, hyperemia, intracerebral hemorrhage and pigmentation).

2. Formative change (ectasia, narrowing, collapse and obliteration).

3. Atrophic and degenerative changes.

Zange (1911) in a case of a tumor of the cerebellopontile angle found degenerative atrophy of the peripheral cochlear nerve. With neoplasms of the connective tissue he found infiltrations of the round cells in the canals spiralis of the cochlea, vascular engorgement and extravasation of blood in all portions of the inner ear. He attributes the latter to

compression of the vena auditiva interna in the inner auditory canal.

Lange (1913) found in 4 cases of acoustic nerve tumor besides slight degenerative changes hyperemia, extravasation and transudation of blood in the inner ear and exudate in the perilymphatic space which could be followed through the aqueductus cochleæ into the skull cavity. Pigmentation was also noted. Lange considers all changes as direct or indirect consequences of an increase of intra-cranial pressure.

Alexander (1907) examined a pituitary tumor which proliferated into almost all of the cranial nerve and caused an atrophy of both optic nerve. He found a hydropic degeneration of the perilymphatic tissue of the pars interior, degenerative atrophy of the sensory epithelium of all the labyrinthine nerve endings as well as a localized degenerative atrophy of the papilla basilaris cochleæ. In another case (neurofibroma of the acusticus) he observed fibrin reticula in the perilymphatic space, small cell infiltration in the connective tissue and in the ligamentum spirale and a degenerative atrophy of Corti canal.

Steiner (1911) referred the ear change which he found in two cases of multiple neurofibromatosis partly to disturbed secretion as well described some time ago by Wittmaack (labyrinth hydrops).

(Lauenberg and Manasse (1924) in cases of acoustic nerve tumor found degenerative change and vascular alterations which they designated as choked hydrops in the inner ear.

Brunner examined a case of glioma of the left cerebellar hemisphere with secondary involution of the nervus acusticus. In spite of enormous atrophy of the nervus cochlearis and the labyrinth he found the ganglion, the nerve branches and the end organs of the internal ear in good condition. Moreover he saw vascular changes, extensive hemorrhage in the inner ear and slight exudation. In his opinion the hemorrhage are results of an extensive variation of pressure.

With regard to the findings themselves I refer to the choked ectasia of the pars inferior with Paget's disease (Brunner 1911) and with tumors of the inner ear (hypernephroma—Benesi) of the inner auditory canal.

with cretinism with hydrocephalus and finally also in many cases of turriccephalia. The localized pressure changes or the conduct of excessive intracranial pressure upon the inner ear constitute the chief causes of such change.

Fischer points to the old view of Moos who thinks it is possible that the cranial pressure increased by a brain tumor is transmitted to the inner ear. However he is of the opinion that a compensation may be brought about rapidly by the flowing off of the cerebrospinal fluid into the vertebral canal and by lymph through the foramen cecum jugulare and occipitale magnum (Merkel).

Besides atrophy of the nervus opticus Boettcher found atrophy in the nervous apparatus of the cochlearis and the sensory cells of Corti's organ. Moreover he found widening and abundance of pigmentation. Moos supposes that similar to the hydrops of the optic sheath with larger tumors there might also be a hydrops of the acoustic sheath. In a later work he arrives at the conclusion that the communication of skull pressure increase by a brain tumor to the inner ear might be possible but that the compensation of pressure is favored by the flowing off of the fluid into the vertebral canal and of the lymph through the foramen cecum jugulare and occipitale magnum. This may explain why with brain tumors the choked disc is found more frequently than is disturbed hearing.

As to the rest the findings vary a great deal. Thus Winkelbauer and Brunner among cases of frontal brain abscess found 4 cases of disturbances in the region of the labyrinth and in not a single case any disturbance of hearing. Brunner after an experimental trauma of the skull found exudate excretion of fibrin and transudate in the inner ear in pathological cases of trauma he found bleeding and blood pigment in the labyrinth as well as ectasis of the ductus cochlearis of the second turn of the cochlea and the gyrus semitertius of the cochlea. Changed condition concussion of the brain may be partly explained by vasomotor disturbances. Brunner from the clinical view point found the nervus acusticus affected in 43 per cent of the cases of concussion of the brain.

The choked disc will always enjoy an indisputable standard as a diagnostic means it may be ascertained by just one simple investigation. For the purpose of examining the labyrinth we make use of the labyrinthine reflexes whereas with the cochlea we depend upon the reactions of the examined patient viz upon what he answers to our questions during investigation and we are thus exposed to mistakes and deception. Until further indications for the diagnosis of a choked ear are known we cannot dispense with repeated investigations at certain intervals for it is exactly the variety or the slow progress of the symptoms which allows us to determine with any certainty the diagnosis of a choked ear.

Fischer has already emphasized the fact that the findings of the inner ear may vary with brain tumors and we must comply with his conclusions that by systematic and repeated investigation the number of positive findings will rise.

We may diagnose symptomless labyrinthine affections since the spontaneous nystagmus and the examination of the reflex excitability will reveal to us exactly the condition of the labyrinth. This method however fails in the case of the cochlea. If the patient in question does not complain of poor hearing only occasionally are we able to diagnose a symptomless affection of the cochlea because of the modern means for acoustic examination.

On this occasion I refer to the shortened conduction of sound by the cranial bones in a normal ear after skull injuries. Such findings however do not offer great reliability as the patient soon becomes tired. The same holds good for testing high and low sounds for on account of the vague results we have to repeat such tests and the patient becomes tired and inattentive. We are thus liable to be deceived by positive results. Progress may be expected only when an improvement has been made in our diagnostic methods.

In the foregoing I have said that the free and unequivocal cases of choked ear involve the pars inferior but not the pars superior. At the present time a clinical diagnosis of these combined affections of the sacculus and cochlea will be impossible and the diagnosis of disturbed function of the sacculus is still

rather distant. Today we shall only in exceptional cases be able to differentiate clinically the disease of the vestibular portion of the cochlea from that of the semicircular canal and for the moment we have not at our disposal any standard for recognizing disturbed secular function in pathological case. We may be able to diagnose the choked ear only by an improved functional test in the region of the cochlea by making use of the acoustic reflexes and by improving the clinical diagnosis of the disease of the vestibular portion of the cochlea. We are still far from the minutiae of examination and diagnosis of the labyrinth which is possible with that of the *tundu oculi*. When we see how exactly the ophthalmologist can prove affection of the viceria of the eyeball and ascertain their degree we have to admit the lack of perfection in the diagnosis of labyrinthine disturbance.

In regard to histological findings we are all still behind ophthalmology. In case of intracranial pressure with exitus lethalis the fundus examined histologically the question whether there are symptoms of obstruction will have to be answered clearly, no matter whether there have been any local symptoms of the disease or not. Well in the case in which no clinical examination has been made. In examining the ear in this way we must in view of the many technical manipulations (decalcification etc.) which are necessary for the procedure be very cautious and reserved when we discover histological changes in a case which is either having no clinical symptoms or which has not been examined at all. It is known that the sensory epithelium and the cuticular portion of the labyrinth react rapidly and markedly both to change of pressure and to change of chemicals. The presence of artifact is of considerable importance here in the histological picture. Hence also in this direction an improvement will be necessary inasmuch as we shall have to dispense with the decalcification in such cases by cleansing the membranous portions so as to examine histologically the wonderfully retained object. Improved clinical diagnosis of the labyrinthine diseases and improved histological technique will point the way by which we shall solve the problem of the choked ear.

Although the study of the phenomenon of nystagmus is valuable both clinically and experimentally in labyrinthine affections nevertheless far greater progress will be made by widening our pathologico-anatomical knowledge of man.

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t. h. f. Oh. h. l. k. l. r. y. o. Ph. o. l. q.  
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I. l. A. t. t. h. k. O. l. r. f. l. b. T. m. e. d.  
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8. B. r. t. l. t. l. t. l. S. r. n. n. m. F.  
9. C. t. l. H. v. C. n. d. f. t. g. l. t. r. v.  
m. h. m. f. t. h. t. c. i. t. h. o. t. l.  
l. l. t. r. e. l. l. o. m. p. e. s. o. B. l. l.  
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## THE HEART IN PREGNANCY

B I R P S A C A M M I T O I F C H F D E N S A R K  
I F F O I I C I L y C C b g

THE physiology of normal pregnancy presents numerous problems of interest. It has been the field of many brilliant investigations and yet it still is one of the most incompletely charted regions of physiology. Be it said it often is very difficult to draw the borderline between the physiology and the pathology of pregnancy.

From the very moment the cumulus is implanted in the uterus it keeps on exerting more and more strain on the maternal organism and during the months of normal pregnancy there is a steady increase of the demand from practically every organ of the mother.

The paramount requisite is that the fetus receive the substance essential to the development of its organism and that it at the same time get rid of its waste product. Obviously the organs of excretion and secretion—the digestive tract, the liver and the kidney—in particular are strained under the pressure of the increased demand.

As already stated there is hardly a single function of the maternal organism which is left unaffected by gestation and the function of the circulatory system is of course of the greatest consequence for it is the heart action of the mother which insures the necessary nourishment of the fetus and the removal of the waste product of metabolism.

This question naturally arises: How does the circulatory system of the mother cope especially the heart react toward the new task the increased work with which it is encumbered during pregnancy?

Only when we have a clear understanding of how the normal heart acts in normal pregnancy are we able to account for the heart action in various degrees of pregnancy and especially to appreciate the effect of pregnancy on the injured heart.

As late as 1921 Mackenzie in his *Heart Disease and Pregnancy* justly criticized the attitude of the obstetricians toward modern cardiology. We must admit I am sorry to say that he is right when he stated that

even the latest textbooks of obstetrics did not contain the slightest indication that any advance has been made in the study of the heart during the last forty or fifty years.

This harsh verdict does not hold true today. Since the publication of Mackenzie's book in 1912 a great many studies have been reported which fully prove that the obstetricians have realized the importance of the viewpoints and method of examination which characterize the modern cardiologists and they have—frequently in collaboration with the internists—carried on the work in this field. It suffices to mention the name of Levy Herrick Kautsky, Bredt and White, Vigne, Lebin and William.

At the University Clinic of Copenhagen we too have lately taken up the question of heart action and the change of the heart in pregnancy. Together with the internist Norgerland and my assistant Dr. C. Jensen I have endeavored to elucidate various conditions pertinent to this question.

In considering the subject of the heart of apparently perfectly normal and healthy women in pregnancy we meet the following question:

Are changes of the heart action manifest in normal pregnancy? If so what is the cause of the change? Can they be mistaken for cardiac heart lesion?

To be of general value investigations of this problem must comprise a relatively large number of cases and should be started as early in pregnancy as possible. We have therefore attempted to study a fairly large number of cases making regular examination throughout the entire period of pregnancy, puerperium and usually for some time afterward.

Beside the usual method of clinical examinations we also have made use of fluoroscopy and X-ray plate electrocardiography and in a smaller series of cases have made a determination of the minute volume of the heart, i.e. the amount of blood circulation.

TABLE I—SYMPTOMS

M t h p gn cy	N mbe f	E l g d h t bo d	Blood p es N N m l	P le- t creas	F t m m m	A c t f P	E tr y t l	M m m m t lost m	Dy p oea	V p ls	Ed m	Alb m
5th	4		N		4	4	4					
6th	6		N	3		9	8				9	
7th	7		t		19	7	9		9			8
8th	35	3	N	9	9	8	3	4	7	3	9	7
9th	39	33	N	8	33	33	7	3	4		34	9
p p	39		N			8	6			5		3
4 d ys b p	39		N			4						

through the heart in one minute Krogh and Lindhard's method was used for this determination

The total number of pregnant women we have studied in this manner is 327 but for various reasons the examinations could be completed in only 239 cases. As to the selection of the material we have taken only women at the age of 20 to 35 years; they all were primiparæ or II paræ. All the women were of normal physique. The weight at start of pregnancy varied between 55 and 65 kilograms, the height was 150 to 170 centimeters. The patients were examined every 3 weeks during the entire period, as a rule the investigation of each case was commenced in the second or third month of pregnancy.

The usual examination consisted of auscultation, pulse and blood pressure measurement before and after exercise, record of weight and X-ray and electrocardiographic examination.

The majority of these women went through pregnancy and confinement without presenting any symptoms of a circulatory nature. Nor did the usual clinical methods demonstrate any disturbances apart from a frequent accentuation of the pulmonary second sound during the last half of gestation and an occasional occurrence of extrasystoles and faint murmurs.

However, a more particular investigation showed that 39 out of the 239 perfectly healthy pregnant women were of special interest inasmuch as they presented some pronounced circulatory symptoms during the

last half of gestation, symptoms which were so pronounced during the last 2 months as to suggest an organic heart lesion.

The symptoms presented by these patients are given in Table I.

Many of the patients—24 of the 39—complained of dyspnoea during the last months of pregnancy. The urine contained albumin in 19 instances. Oedema was present in 34 cases. Physical examination showed enlargement of the heart, rapid pulse, murmurs and accentuation of pulmonary second sound. I wish to emphasize, however, that the blood pressure was measured repeatedly and practically always found to be normal.

Another characteristic feature, which is evident from the table, is that murmurs rarely were heard over the mitral orifice and were of the type called functional. I do not find this term particularly appropriate but it is commonly used. Williams, for instance, uses it in his textbook. I would like to suggest the term gestatory murmurs, because this seems to me to be more to the point as it conveys the idea of the transitory heart disorders during the last part of gestation.

The chief complaints of these patients were cardiac pains and distress, headache and shortness of breath. The physical examination showed as mentioned rapid pulse, extrasystole, visible venous pulsation and systolic and diastolic murmurs at the base of the heart over the pulmonary and tricuspid valves.

Furthermore, it is characteristic that the lesion was not aggravated by work, nor was it improved by digitalis and rest in bed. In

TABLE II—FINDINGS IN ONE HUNDRED EIGHT EEN PREGNANT WOMEN WITHOUT FUNCTIONAL HEART DISEASE LIMIT OF ERROR—0.7

	Lo		D m		F H		t d m	
	l	R	l	R	l	R	l	R
1st th t	1	16	8	3	8	77		
5th th t	39	9	6	33	1	64		
Light t m th	57	4	37	?	?	?		
1st th t	4	9	105	0		7		

several instances the patients claimed to feel better while moving around.

The main interest however is associated with parturition itself. For even by the most careful observation it was impossible to demonstrate any aggravation of the symptoms during this stage. These women were not exhausted neither during the labor pains nor in the intervals the respiration remained regular throughout and the blood pressure was normal. Of the patients 37 delivered spontaneously were delivered by forcep when the head was on the pelvic floor. This last procedure was really not necessary but it happened early in the series of investigations and we were not yet sure whether the heart disturbance were of functional nature or due to organic heart disease.

The correctness of our views however was proved most strikingly by our examinations of the patients during puerperium.

The percussion tones were normal and the murmurs had disappeared as early as the day after parturition. As you will notice in the table practically all symptoms had subsided before discharge. The condition of these patients was once more perfectly normal.

TABLE III—FINDINGS IN THIRTY NINE PREGNANT WOMEN WITH FUNCTIONAL HEART DISEASE

	Lo		D m		F H		t d m	
	l	R	l	R	l	R	l	R
1st th t	8	6	25	4				
5th th t	3	15						
Light t m th	7	3	9	?	?			
4th th t	3	1	3	0		3		

TABLE IV—THE IDEAL VALUES OF R AND S DURING PREGNANCY

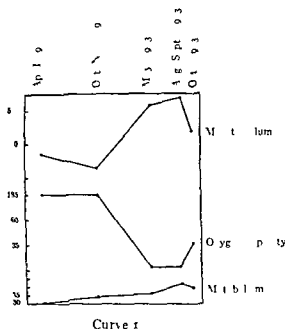
	R		S		R		S	
	l	R	l	R	l	R	l	R
1st th t	14	83	1	86				
5th th t	13	78	2	2				
Light t m th	2	36	0	106				
1st th t	4	91	5	6				
5th th t	4	1	3	96				
Light t m th	14	3	1	8				
1st th t	14	83	3	36				
Light t m th	6	35	4	4				

I find it of the greatest importance that the obstetrician as well as the general practitioner realize that such functional—heart disturbances do occur in pregnancy that they are relatively frequent and that they are of no consequence whatever during parturition.

It is evident from works by Gerhardt, Jacquemier, Kehrer, Fellner, Wilson, Robinson and others that these heart disturbances are quite well known in them selves and yet they have not received proper attention primarily because only a systematic examination throughout the entire period of gestation makes it possible to distinguish the cases of functional heart lesion from cases of organic heart disease.

As a rule however one does not see these patients until late in pregnancy when they complain of their subjective symptoms. If at that time an increased area of heart dullness, murmurs over precordium and accentuation of pulmonary second sound are found one may very readily make a diagnosis of organic heart lesion and treat the patient accordingly.

This holds good to a still larger extent if one does not see the patient prior to parturition in which case this fact becomes more imminent inasmuch as the management of labor will naturally be influenced by the wrong diagnosis—just as it was in the first 2 cases of our series. I do not do but that quite a number of cases of functional heart disturbances are included among the cases of heart disease which are treated in obstetrical departments everywhere. This in turn means that statistics will vary a good deal depending on how many such cases have been entered under the diagnosis. Ab cordi



Curve 1

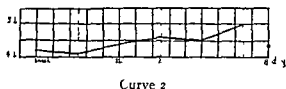
Before I attempt to explain these changes I wish to call attention to the results of our systematical X ray and electrocardiographic examinations. X ray examinations were made of 157 patients the first examination being made as early as in the second or third month of pregnancy.

Table II comprises 118 cases of pregnancy with no cardiac disturbances whatever during the entire period of gestation. It shows an increase of the longitudinal as well as the transverse diameter in 23 cases as early as in the fourth or fifth month. This increase of the diameters becomes more frequent in the sixth or seventh month when the longitudinal diameter was increased in 39 cases the transverse in 33.

It should be borne in mind that these measures were taken at a time when the upward pressure on the diaphragm could be of no particular consequence. For the same reason we have attributed no significance to the measures in the eighth or ninth month at this time we found the longitudinal diameter increased in 67 out of 118 cases i.e. about 50 per cent.

Examinations to 4 weeks after parturition showed that both the longitudinal and the transverse diameter had returned to practically normal measures.

Table III gives the X ray findings in the 39 women I have characterized as suffering



Curve 2

from a functional heart lesion. In the sixth to the seventh month the longitudinal and the transverse diameter were enlarged in 21 and 2 cases respectively the longitudinal diameter was enlarged in 7 cases in the eighth to ninth month.

In these cases the changes disappeared shortly after parturition. The patients presented many signs of circulatory disturbances during pregnancy but in no instance could these changes be demonstrated 4 weeks after parturition.

I realize perfectly well that one has to be very cautious in estimating the size of the heart from X ray plates—particularly in pregnancy yet I am convinced—in conformity with Frey for instance that these findings do justify one in the claim that the enlargement of the heart diameters quite often can be demonstrated at an early stage of pregnancy when the upward pressure upon the diaphragm is as yet of no consequence. It is worth noticing that in the cases I have diagnosed as functional heart lesion the diameters were enlarged in about 50 per cent of the cases in the sixth or seventh month and in 70 per cent in the eighth or ninth month.

We now come to the question which has been touched on by so many authors and has been discussed in particular by Frey, Kautsky, von Jaschke, Sellheim and Robert Weiss. Is this demonstrable enlargement of the heart due to a hypertrophy or a dilatation or perhaps both? Or is it merely an apparent enlargement due to the changed position of the heart?

We took the position of the heart axis in the different months of pregnancy into account and computed the ideal values for R and S respectively by means of Einthoven's triangle. If the two ventricles did not undergo any change in the course of pregnancy the difference R - S would remain unchanged.



C ve 3

Table IV shows however that  $R - S$  gradually decreases until the sixth month of pregnancy from 12.9 to 9.1. It then rises again and attains its previous value shortly before parturition. This fact becomes still more conspicuous when it is presented graphically as I have done in the curve of Curve 8. Here the difference is seen to decrease markedly until the 10th month whereafter it again increases.

Table IV shows that this decrease of  $R - S$  was due to an increase of  $S$ . As far as we now know this means a predominance of the left ventricle. The difference is compensated from the sixth month on, as illustrated by the rise of the curve toward the original level.

These are the electrocardiac changes that we consider indicate that the left ventricle undergoes hypertrophy in the first 6 months of pregnancy and that this hypertrophy is compensated in the last months by a proportionate hypertrophy of the right ventricle. Perhaps our interpretation may be criticized but there can be no doubt of the correctness of our observations. *The functional equilibrium of the two ventricles is disturbed in most cases of pregnancy even the normal ones.*

The view that the heart muscle really does undergo some changes is supported by the fact that the electrocardiographic changes can often be demonstrated a whole month after parturition while the X-ray changes which at any rate largely depend on the rotation of the heart disappear relatively soon after parturition.

We have endeavored to contribute to the answering of this question by the electrocardiographic examinations which Dr. Norgaard has carried out. We have studied 32 patients systematically. It has been a very extensive piece of work as we have computed about 12,000 values for the different leads on the basis of these electrocardio-

grams. Our material then is so large in figures that one can reasonably take it for granted that accidents have had no influence on the results.

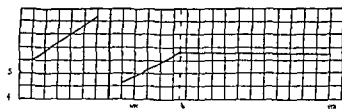
Without going into details of the technique I wish to point out that all conceivable source of error were taken into consideration as far as possible including the ever recurrent rotation of the heart in pregnancy. We now think that the electrocardiographic change of pregnancy which we have found in practically every case and which becomes particularly conspicuous because of the altered function of the two ventricles should be interpreted in this way. During the first 6 months of pregnancy the left ventricle undergoes a relative hypertrophy in proportion to the right ventricle and from the 10th month to parturition this hypertrophy is compensated by a hypertrophy of the right half of the heart. There is perhaps also a slight dilatation of the right ventricle and right atrium. The electrocardiographic changes can be demonstrated as early as in the third or fourth month when the change in position of the heart can be of no importance.

Without entering too far upon the electrocardiographic mysteries I shall cite an example which illustrates this extremely important question.

It is the general opinion that in the third lead of an electrocardiogram the height of the  $R$  wave is an indication of the function of the right ventricle while the  $S$  wave denotes the function of the left ventricle.

The final cause of these changes is yet purely hypothetical. There can be no doubt that the increased work of the heart is the primary cause of these changes. Hence it will be very significant if it is possible to prove directly that the work of the heart is increased during pregnancy.

The work of the heart can be measured in the form of its minute volume i.e. that



Curve 4

amount of blood which passes through the heart in 1 minute

The most accurate investigations of this question so far are undoubtedly those made by Standers Duncan and Sisson. They used pregnant dogs for their determinations and they determined the minute volume by means of this formula

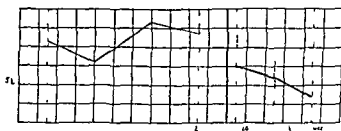
$$MV = \frac{O}{A - V}$$

According to this formula the minute volume is equal to the proportion between the total oxygen intake in cubic centimeters and the difference between the oxygen content in 1 cubic centimeter of arterial blood and in 1 cubic centimeter of venous blood. It is comparatively easy to determine the absorbed oxygen by means of a spirometer. But the determination of the amount of oxygen in the arterial and venous blood requires a heart puncture of the right and left ventricle respectively. By this method Standers Duncan and Sisson have determined the minute volume in two pregnant dogs. They have found this volume to increase gradually during pregnancy and become about 35 per cent larger than before or after pregnancy.

These experiments must be taken as very significant. Their number is not large but they apparently are made with a dependable technique and show conclusively that the work of the heart is increased during pregnancy.

A number of experiments have been made by other investigators in order to demonstrate the increase of heart work in pregnancy but the accuracy of the experiments is not equal to that in the animal experiments just mentioned.

Without entering into the details of the various methods I believe Krogh and Lind-



Curve 5

hard's method must be recognized as the most dependable. In 1925 Henderson reported a new method which does not seem to offer any advantages in preference to that of Krogh and Lindhard. According to these authors Henderson's method is even encumbered with certain errors.

In Krogh and Lindhard's method the patient studied respire into a spirometer which contains air mixed with a definite amount of nitrous oxide. After having made some respirations the patient holds her breath 1 minute or so and then expires. By analyzing the alveolar air at the start of the experiment as well as at its conclusion one can calculate the amount of blood which has passed through the heart on the basis of the deficit in nitrous oxide.

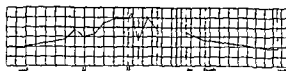
Krogh and Lindhard, Lindhard alone and later Christen Lundsgaard have made numerous determinations with this method which must be said to have been tried out thoroughly.

The first determination on a pregnant woman was made by Lindhard as early as 1912 and it should be emphasized that this determination was made on a woman who was well trained in the technique from many previous determinations, a circumstance which of course makes the result particularly dependable and convincing (Curve 1). The curve of the determinations on this individual shows the minute volume to be 3.7 liters in April 1912. Pregnancy commenced in January 1913. The curve shows how the minute volume increased to 5 liters in the month of May. The woman was delivered in September whereafter the minute volume began to fall; it was 4.4 liters in October.

Lindhard thinks that the increase of minute volume is due either to an enlargement of the vascular system of uterus or to an



L 6



Cu 7

increase of the total amount of blood eventually hydræmia.

Whichever explanation is correct it any rate the increase of minute volume involves an increase of heart action.

Later Wei carried on with Lindhard's method. He was not in a position to follow the pregnant women through the entire pregnancy but limited himself to determining the minute volume in the last days before parturition then he compared the value he found with the average value which Krogh and Lindhard found in healthy non-pregnant women and which he gave as 3.8 liter. In his investigation Wei finds a very marked increase of the minute volume varying from 45 per cent to 50 per cent.

I agree with Lindhard in the opinion that these figures must be taken with some caution. It is true enough that the minute volume increases but it is hardly likely to increase as much as Wei has found it to do and his experiment is lacking that control which would have been possible if he had been able to examine the same patient in the beginning of pregnancy and some time after parturition. Weiss too considers the increase of minute volume due at least in part to an increase of the total blood volume.

In 1925 Liljebrand and Stenstrom reported the results they found in determining the minute volume in a number of women with chronic nephritis. There was a pregnant woman among these. Her minute volume increased during pregnancy to 6 liters and went down to 4.9 liters after parturition. Although one cannot overlook the fact that chronic nephritis in itself is a reason for an increase of the minute volume this experiment still shows that pregnancy has an influence which tends to increase the minute volume.

In 1927 Weiss reviews the different methods of determining the minute volume of the

heart. The most important part of this study is his conclusion that the minute volume in human can be determined with relatively great accuracy but that the method is still very difficult and requires so much training of the experimental subject that it is far from being practicable as a clinical routine method. One still has to consider the results with a certain reservation.

We too have entered on the investigations in the Lying In Hospital. Together with Mr. Dr. Gormsen and later with Mr. Dr. Jørgensen we have succeeded in completing our experiments. We have started the experiment as early in pregnancy as possible and have continued the determinations until some time after parturition.

As already mentioned the technique is far from being easy and it requires a great deal of training of the experimenter as well as the experimental subject. Some of the experiment had to be relinquished because it was impossible to teach the individual to breathe in the right fashion. We have been very fortunate in this that Professor Lindhard was so kind to teach Dr. Gormsen the technique and to let her do the first experiments under his supervision.

In the case illustrated by Curve 1 the first determination was made in the twelfth week of pregnancy. At that time the minute volume was about 4 liters. It increased gradually during pregnancy and amounted to 5.5 liters in the thirty-seventh week. A single determination 8 days after parturition showed that the minute volume now had fallen to 4.4 liters.

Another experiment (Curve 3) was started in the sixteenth week when the minute volume was a little more than 5 liters. During the remainder of pregnancy it kept quite constantly about 5.5 liters. In this case we were able to make a determination 9 days after parturition as well as 3 months and

13 months later. The minute volume was found to be considerably lower in all 3 instances namely 4.5 liters.

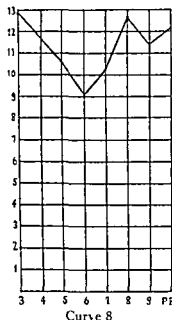
In the following experiment (Curve 4) the first determination was not made until the twenty eighth week. At that time the minute volume was 5.5 liters from then on it increased rather markedly and it was 7.5 liters shortly before parturition. Three weeks after parturition the minute volume was as low as 4.6 liters while it stayed around 5.75 liters about 15 months after parturition.

The result of the next experiment (Curve 5) is similar to that for the others there is an increase in minute volume toward parturition and a considerable decrease after this.

The same holds good for the next experiment (Curve 6). In this case too we were able to examine the patient 1 year after parturition.

The last curve (Curve 7) is of particular interest. It illustrates the minute volume determinations made on Mrs. Dr. Gormsen who has made a number of these experiments herself. Mrs. Gormsen was particularly well fitted for these determinations as she had instructed all the other experimental subjects in the technique of the experiment. Several experiments were made on her as early as June 1924 at that time her minute volume was found to be 5.55 liters. She became pregnant in 1925 whereafter the first experiment was made on her in the eighth week. Her minute volume was determined at 8, 18, 20, 22, 24, 26, 30, 33, 35, 37 and 39 weeks. These determinations show that the minute volume increases gradually during pregnancy and reaches its maximum in the thirty third week where it is 5.65 liters. The decrease in the thirty fifth week undoubtedly is due to the fact that at this time the patient discontinued all work and rested at home. Nevertheless the minute volume increased again in the thirty seventh week. After parturition 3 determinations were made the last one 4 months after delivery at that time the minute volume had gone down to exactly the same value as in the eighth week of pregnancy namely 5.0 liters.

This experiment was carried out under the most favorable circumstances on an in-



dividual who fully mastered its technique and who from personal experience was familiar with its sources of error. I attach a very great importance to its results. On that account I do not hesitate to assert that our experiments have proved that the minute volume of the heart increases and that the heart action in this manner is increased during pregnancy.

In this connection it does not matter whether the increase of volume is due to an anemic condition in pregnancy or what I find most likely to an increase of the total amount of blood which has been demonstrated for instance by Zuntz, Stander and Credidick, Mahnert and Kaboth. It should be mentioned however that Lindhard has passed a severe criticism on the methods employed. Still all findings go to show that the total blood volume is increased during pregnancy.

The heart action is increased in pregnancy as a result of the increased total amount of blood and the increased minute volume. This explains the development of a hypertrophy and perhaps also a dilatation. Both conditions become particularly pronounced in such cases in which the heart is poorly trained. One might be justified in saying in such cases in which the reserve force of the heart is relatively small.

Even though our investigations do not conclusively prove that a hypertrophy of the



heart occurs in normal pregnancy we still believe that our roentgenological and cardiographic investigations have helped to solve this question. Moreover our investigations have shown in conformity with earlier investigators that apparently normal and healthy women may during pregnancy develop symptoms which must be taken as a functional heart lesion while they often no doubt have been considered organic heart disease.

James Mackenzie, one of the leaders in the development of the modern cardiology has continuously emphasized how little significance can be attributed to a single examination. Only by repeated examinations—in this case throughout the entire period of pregnancy and eventually for some time afterwards—can one obtain a clear apprehension of the most essential point, the prognosis.

Pregnant women with a functional heart disorder are not benefited by a diagnosis of organic heart disease. Much anxiety and many radical measures could be avoided in this condition which is so well known in internal medicine likewise became as greatly appreciated in obstetrics. In his textbook of obstetrics Williams says with regard to hypertrophy of the heart in pregnancy: "The question however cannot be regarded as definitely settled and offers an attractive field for future work. I fully endorse the words: 'The question of the heart in preg-

nancy is far from settled. It still offers an attractive field for future work."

#### DISCUSSION

DR. REUBEN PETERSON: So far as the heart in pregnancy is concerned there can be no criticism of the facts stated by Dr. Gammeltoft. Perhaps because we have not made as close a study of heart in normal pregnant patients as has been done we have not seen as many patients with the symptoms he has outlined: rapid pulse, extrasystoles and venous pulsations. As a matter of fact when such symptoms exist we have not ascribed them to the heart but to the patient's general nervous condition.

In the University Clinic we have been most fortunate in having at our command the opinion of such an eminent heart specialist as Dr. Frank Wilson who has relieved us of the burden of deciding in doubtful cases whether or not the patient has an organic heart lesion.

I quite agree with the essayist that the heart in pregnancy and labor is a very important subject. If the patient suffering from organic heart disease the obstetrician is called upon at times to exercise the most accurate judgment as to prognosis and treatment for either or both.

Unlike uterine fibroids the very existence of the patient may depend upon sterilization so that the patient's overburdened heart may not have the added strain of a pregnancy of even short duration. If the patient with organic heart disease does conceive the question arises as to whether the pregnancy is to be terminated at once or allowed to proceed until the child is viable. Yet these and many other aspects of the question are outside the scope of the essayist's paper and may not be discussed. Any light upon the relation of the heart to pregnancy which will be of aid to us in solving the occasional obstetrical problem in this connection is always of value.

# CLINICAL SURGERY

FROM THE II FRAUENKLINIK VIENNA

## THE WERTHEIM OPERATION FOR CANCER OF THE CERVIX UTERI

By PROFESSOR DR. PAUL WERNER VIENNA, AUSTRIA

THERE is no other gynecological operation which carries with it so much danger and is so destructive as is the abdominal operation for cancer; this is especially true if the operator is not familiar with the technique and does not know every detail necessary to prevent complications. The main dangers are a high primary mortality, recurrence if radical removal has not been done, and the possibility of damage to all the organs adjacent to the uterus. The organs to be considered most carefully are the urinary bladder, ureters, and rectum. The procedure which the II Frauenklinik formerly conducted by Wertheim has adapted with the hope of avoiding as far as possible the dangers associated with the operation is as follows:

### PREPARATION FOR OPERATION AND ANÆSTHESIA

The patient should not be examined by vagina or rectum for 3 or 4 days prior to operation and no excision should be made during this time. Every cancer is infected. Therefore any manipulation may force the infection into deeper tissue leading to a postoperative peritonitis or sepsis. Conforming with these ideas we have recently abandoned curetting, cauterizing, or even packing the vagina as is done in many other clinics as a preparatory measure for this operation and in a large series of cases we have found that no harm has followed our practice.

The anæsthesia of choice is spinal, 1 cubic centimeter of 10 per cent tropacocain given one half hour after 0.05 grams of pantopon subcutaneously. We have found that the use of spinal anæsthesia not only prevents postoperative lung complications and gives absolute relaxation to the abdominal wall to an extent not to be obtained in any other type of anæsthesia, but also it makes possible the securing of an operative field from which the intestines are excluded so that we remove the chance of mechanical injury or infection to the intestines. A similar degree of relaxation of the abdominal wall can be obtained only approx-

imately by inhalation anæsthesia and the patient is then so deeply anæsthetized that life is endangered. As the intestines are never in the field of operation, never manipulated and so never injured, we are able to avoid irritating the peritoneum so often done formerly and also we are able to maintain almost normal peristaltic movements of the intestines after operation.

### OPERATIVE TECHNIQUE

The patient is placed in the extreme Trendelenburg position. After the usual disinfection of the abdominal wall, an incision is made from the umbilicus to the symphysis. It is important to extend the incision to the symphysis because resection of the deeper tissues is thus facilitated. Many of the difficulties encountered in these operations have been due to the fact that the incision was not carried down far enough. After walling off the pelvic cavity and placing a self-retaining abdominal retractor, the operative field is examined by inspection and palpation; the glands of the bladder, the parametrium, and the rectum. The most careful clinical examination will not always give exact knowledge of the existing conditions. If contra-indications are not present, the operation is begun as follows:

*First step—separation of the bladder.* The second assistant stands at the left of the operator and with his right hand pulls the vulsella attached to the uterus cephalad. The operator with a thumb forceps in his left hand lifts the peritoneum of the bladder at a point just between the insertion of the peritoneum on the uterus and its connection with the posterior wall of the symphysis in this way bringing up a long longitudinal fold (Fig. 1).

This fold is incised with blunt scissors midway between the forceps and the uterus. This incision is continued arch like on both sides to the round ligaments. Then the bladder is separated from the anterior wall of the cervix and vagina as far as possible. This must be done in the proper layer to avoid unnecessary bleeding. This proper layer—

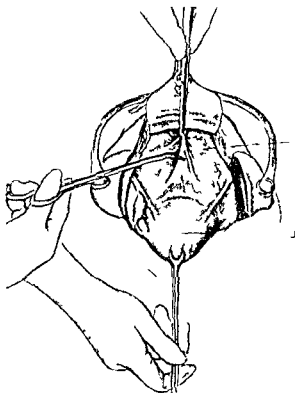


Fig. 1. First step in preparation of uterus.

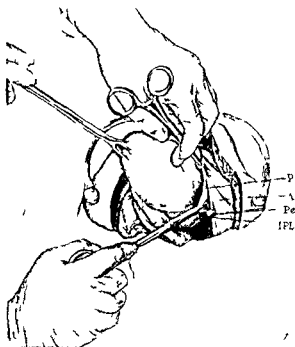


Fig. 2. Second step in preparation of uterus. The second assistant pulls the uterus toward the symphysis and a little to the left, meanwhile the first assistant exposes the connective tissue of the broad ligament by pulling the stump of the infundibulopelvic ligament cephalad and against the posterior

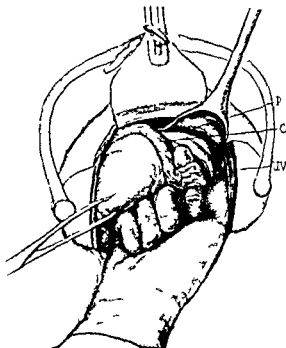


Fig. 3. Third step in preparation of uterus. The second assistant pulls the uterus toward the symphysis and a little to the left, meanwhile the first assistant exposes the connective tissue of the broad ligament by pulling the stump of the infundibulopelvic ligament cephalad and against the posterior

the connective tissue between bladder and cervix—is easily found by lifting the bladder with forceps as high as possible and cutting the folds equidistant from each end.

**Second step—preparation of ureters.** We always begin on the right side first by cutting the infundibulopelvic ligament between the ligature and the Pean's clamp. Then the two layers of peritoneum are separated by closed scissors (Fig. 2) until the opening is made large enough to introduce the right index finger and continued down to the lateral pelvic wall. A complete separation of the two layers is important so that the ureter may be speedily located.

Next the anterior or lateral layer is cut horizontally as far as the round ligament, the posterior or medial and then obliquely down to the pelvic wall. The exact cutting of the peritoneum is not only very useful in locating the ureters but is of greatest importance for a proper peritonealization of the wound after the uterus is removed. The round ligament is now cut and the ureter is located in the following manner. The second assistant pulls the uterus toward the symphysis and a little to the left, meanwhile the first assistant exposes the connective tissue of the broad ligament by pulling the stump of the infundibulopelvic ligament cephalad and against the posterior

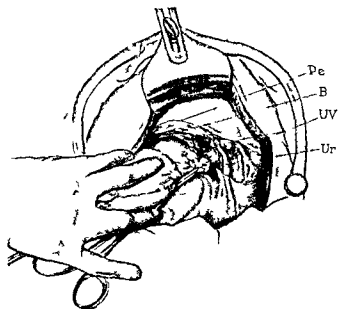


Fig. 4 The operative field after the vessels have been cut. *Pe* peritoneum *B* bladder *U* uterine vessels *Ur* ureter

abdominal wall. The cut edge of the posterior layer is grasped by the operator with a thumb forceps and dissection is carried down along the peritoneum to the location of the ureter which is always closely related to the posterior layer of peritoneum. As soon as the ureter is found the dissection is carried down to the bladder. The ureter is not dissected entirely free but is left connected with the lateral pelvic wall except in advanced cases when the entire pelvic connective tissue has to be removed. Then the ureter must necessarily be dissected free in its entire circumference. While dissecting down the ureter one approaches an area in which the connective tissue fibers run in an arched manner over the ureter carrying the uterine vessels. As soon as this place is approached a tunnel is built by closed scissors blunt dissection above the ureter and below the arch like fibers. Into this tunnel the right index finger can be introduced so that on the finger are the uterine vessels and below the finger is the ureter (Fig. 3). Under the guidance of the finger a silk suture is carried in a Deschamps needle under the vessels which are tied and cut. By this method we are able to avoid any injury to the ureter which in previous operations was very common. Figure 4 shows the operative field after the uterine vessels have been cut. Now it is easy to dissect the vesical ureter and the adjacent portion of the bladder as far down as possible (Fig. 5). A similar procedure on the left side frees the uterus in front and on two sides (Fig. 6).

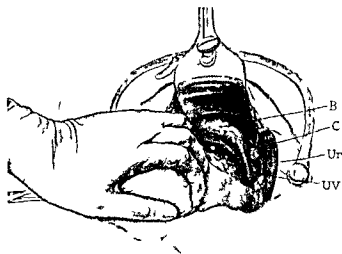


Fig. 5 Dissection of the vesical ureter and adjacent portion of bladder. *B* bladder *C* cervix *Ur* ureter *U* uterine vessels

*Third step—exposure of the posterior side and separation of the rectum.* The rectum is dissected in the following way. The uterus is lifted out against the symphysis as far as possible. The first assistant is pulling the rectum out of the pelvis and pressing it against the promontory of the sacrum with his left hand (Fig. 7). In this way Douglas's pouch is flattened. This enables the operator to take up with a thumb forceps in his left hand a fold between rectum and posterior vaginal wall and cut it transversely. The incision is continued on both sides through the peritoneum of the sacro uterine ligament to the posterior layer incision made primarily for the exposure of

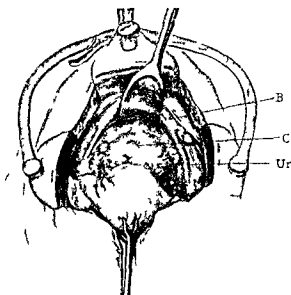


Fig. 6 The uterus free in front and on two sides. *B* bladder *C* cervix *Ur* ureter

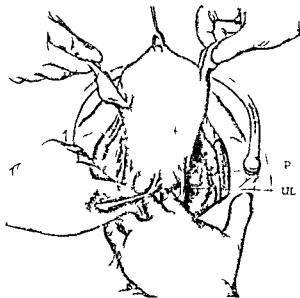


Fig. 9. C. d. p. m. t. l. lamp

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the ureter. The operator now grasps the uterus with his left hand and lifts it while separating the rectum from the posterior vaginal wall bluntly with the right hand down against the perineum. This is a rule, very easily done. The uterus is now free from all sides and can be extirpated.

**Fifth step.** We start as a rule with the right parametrium. By lifting the uterus forward and to the left side the parametrium becomes tense. Curved parametrial clamps (Fig. 8) are applied to the broad ligament as near the pelvic wall as possible beginning with the sacro uterine folds and going on step by step to the vaginal canal. The tissue is cut and when this is done on both sides the uterus is attached only by the vagina and can now be removed by cutting through. The opening of the vagina was formerly feared as the most dangerous step of the operation because then the infection of the carcinomatous area have their opportunity of entering the abdominal cavity. Wertheim tried to avoid this danger by applying two strong right angle clamps below the cancer to the vagina thus closing it beyond the dangerous growth and cutting below the clamps. This method without doubt will avert infection of the peritoneum through the vagina but it makes the operation very difficult because there is very little space for cutting the vagina below the clamps and the entire work has to be done deep in the pelvis. In the past few years we have avoided the dangers of infection in the following simple easy and satisfactory way.

**11th step.** As soon as the uterus is released from all its attachments except the vagina the latter is cleaned and dried out with dry pieces of gauze through the vulva. Then a gauze sponge is firmly pressed against the cancerous area and the vagina below the gauze pack is again cleaned. After this the operator returns to his place and grasps the vagina with his left hand by placing the thumb in front the index finger behind thus holding the gauze against the cancerous area and cuts the vagina below with scissors (Fig. 9). As soon as the anterior vaginal wall is cut a strip of gauze is introduced through this hole into the vagina to prevent any remaining contents from entering the field of operation. Then the vaginal attachment is completely severed and the uterus is removed. A few stitches are placed in the vaginal stump to control bleeding and clamps are replaced by ligatures. By using the curved clamps which follow the pelvic curve the pelvis may be cleaned out entirely so that the slightest amount of fat or connective tissue remains. Figure 10 shows the left half of such a pelvis where the levator ani can be seen entirely exposed. After an exact control of hemorrhage the area is again examined for any enlarged glands. It must be remembered that such glands are always in close relation to the iliac vessels and obturator nerve and separation is often very difficult. Great care must be exercised not to ligate the obturator nerve as this would cause long lasting pain in the leg.

Finally a strip of iodoform gauze is placed in the operative field and an incision extended through the vagina. The bladder peritoneum is sutured to the rectum and suturing is continued on each side to the infundibulopelvic stump which separates the entire operative field from the abdominal cavity (Fig. 11). The peritoneal apposition must be very accurately done in order to avoid postoperative peritonitis. Finally the abdomen is closed in the usual way.

The difference between this extensive operation and simple extirpation is that the uterus alone is not removed but the adnexa also the parametrial tissue and an extensive portion of the vagina. This is done in order to follow the general surgical law to extirpate a malignant tumor.

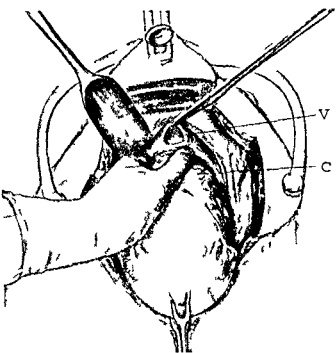


Fig 9 With gauze held against the cancerous area the operator cuts the vagina below the scissors leaving the cervix

thoroughly so that only healthy tissue is left. This is possible only when preliminary dissection of the ureters—the most important point in the entire operation—is done.

#### AFTER TREATMENT

As in all other laparotomies the patient is put to bed and left absolutely quiet. There are no infusions or other medication given except a hypodermic injection of morphine 0.02 grams the evening after the operation to procure a restful night. Shock is never observed after the operation perhaps due to the fact that the intestines have not been manipulated. Forty-eight hours after the operation the patient receives an enema of chamomille tea to facilitate peristaltic action. If the bowels do not act after the tea enema the patient is given a glycerine water enema. On the fourth day the pelvic strip of gauze is partly removed and a little more is taken out each day until the eighth day when the last of it is removed. Five days after the operation the stitches are removed. It is advisable to have the patient brought to the examination table 2 days after the removal of the gauze and to introduce forceps through the vagina into the parametrial wounds to permit the escape of any secretions that may be retained. This may occasionally prevent severe phlegmon of the retroperitoneal cellular tissue or secondary peritonitis. Especial care must be given the bladder. There is always complete

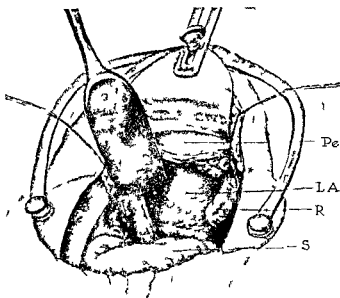
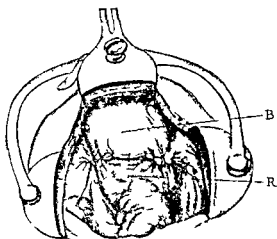


Fig 10 Levator ani entirely exposed on left side of peritoneum. LA levator ani, P rectum, S sigmoid.

retention of urine due to the extensive dissection and isolation of the bladder. This retention and the consequent cystitis cannot be prevented in fact it may be said that if a patient passes urine voluntarily after operation the operation was not a real extensive Wertheim. The operation by its extensiveness must lead to this bladder disturbance. The bladder must be emptied every 8 hours by catheter and washed with a 3 per cent boracic acid solution. After 8 or 10 days the patient starts to empty the bladder spontaneously but never completely. It would be a great mistake to stop the care of the bladder as a severe cystitis and perhaps even pyelitis might follow. The time for the end of the bladder treatment is determined in the clinic in the following way. The patient is asked to urinate in the morning and immediately afterward she is catheterized. The amount of urine found this way, the so-called residual urine, is measured. Only when no residual urine is found on 3 successive days does the bladder cease to require further treatment. This takes about 3 or 4 weeks.

Postoperative prophylactic radiation is done on every patient. For this only the X-ray is used. Radium emanation does not reach deeply enough and even with most cautious dosage may lead to fistula because of the severely traumatized tissue.

The general rule is to be followed as always to radiate the patient as soon as possible but cautiously. If the radiation is started too early before the abdominal wall has had time to heal and the bladder is not sufficiently recovered severe recurrence of cystitis will follow and



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require extended treatment. Therefore it is best to wait until there is but 10 or 20 cubic centimeters of residual urine before starting radiation.

#### COMPLICATIONS

The most common and most feared complication is the fistula. There may occur fistulae of the bladder, ureter, or rectum. This complication cannot be avoided entirely, especially in far advanced cases in which the new growth has very closely approached the organs. Bladder and rectal fistulae are observed in the cases in which the cancer has grown close to these organs or even into the outer layer of their walls. The outer wall is removed with the growth and the remainder becomes necrotic and sloughs off as a rule within 8 or 10 days. Very little can be done to prevent this because even overlapping with apparently healthy tissue does not as a rule prevent the fistula because of the tissue's diminished resistance and blood supply due to the extensive dissection. Nearly always rectal fistulae all heal spontaneously, even though quite large. Bladder fistulae heal very rarely, even though they are small. After 2 or 3 months the fistula of the bladder must be operated upon and as a rule it heals with primary intention.

If adherent, certain rules will reduce ureteral fistulae to a minimum. If possible the ureter should be left in contact with the lateral pelvic wall. If this cannot be done for instance in very advanced cases, Amann's method is the best way of reattaching the ureter to the pelvic wall by using the stump of the uterine vessels for fixation. The ureters should never be grasped with an in-

strument; all dissecting should be done by holding the surrounding connective tissue. Finally they should not come in contact with any ligatures or even the gauze used as a pelvic drainage. If after all these precautions a fistula does occur spontaneous healing may be expected in the greater number of cases. This healing may take place in some cases in 3 or 4 weeks while in others it will require 3 or 4 months. Therefore surgical interference should not be tried until after this latter time. The only operation to consider is extirpation of the kidney because first it is impossible to dissect the ureter free from the scar tissue far enough to implant it into the bladder without tension and secondly the kidney is nearly always infected at the time of operation and its preservation for this reason is not desirable.

Another severe complication is pyelitis. If 10 or 12 days after the operation and in some cases even later the patient suddenly develops high temperature which may or may not be accompanied by a chill, the possibility of pyelitis should always be considered even though there is no pain in the kidney region and no urinary findings or any other symptoms common to pyelitis.

The kidney pelvis must be catheterized and it is best that the catheter remain for 24 or 48 hours to insure permanent drainage of the kidney pelvis and allow repeated flushes of 1 per cent silver nitrate solution. If catheterization of the ureter is not possible due to severe changes in bladder mucous membrane it is advisable to place a permanent catheter in the bladder and twice a day inject 10 cubic centimeters of 40 per cent urotropine solution intravenously. Pyelitis if not treated or not treated early enough may lead to pyonephrosis and even to death.

#### RESULTS

Wertheim found that 50 per cent of the cases admitted to the clinic for cancer of the uterus could be operated upon; the remainder were inoperable due to the advanced stage of cancer growth or other complications. Of the cases operated upon 50 per cent were alive and well after 5 years. This corresponds to a permanent healing of 50 per cent of all cases operated upon or 25 per cent of all cases coming into the clinic with cancer. Since that time postoperative radiation has been used as a routine in all cases operated upon and the operative technique has been more improved so that the primary mortality has been reduced from 10 per cent to 5 or 6 per cent. I do not doubt that the future will show much better results.

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## FROM THE SECTION ON ORTHOPEDIC SURGERY MAYO CLINIC

MASSIVE BONE GRAFT APPLIED FOR NON-UNION OF THE HUMERUS<sup>1</sup>

BY MELVIN S HENDERSON M D F A C S ROCHESTER MINNESOTA

FOR a number of years we have used the term massive bone graft to distinguish this type from the intramedullary or inlay bone graft. The intramedullary bone graft is placed in the medullary cavity is gradually absorbed and serves merely as a means of fixation. In cases of non union it has proved of little value and in cases of delayed union of but little more therefore it has practically been abandoned. The inlay method although anatomically accurate and seemingly logical has certain faults. The inlay graft must be accurately placed in the slot prepared for it or the necessary contact between the bone graft and the bone fragments will not be obtained. The most serious fault however is that the graft in some positions particularly in the radius and ulna is not of sufficient size to maintain fixation properly during the period from the third to the fifth week which is often spoken of as the weak period of the bone graft. Although autogenous bone grafts are probably mostly absorbed and replaced by new bone I doubt that this process is complete. At the time of maximal absorption of bone there is not enough new bone in a small graft to provide real fixation and it is then that the graft may break.

The massive graft overcomes these difficulties. It is easier to apply and is so large that it really acts as a means of fixation even through the period of weakness because by that time enough new bone has been deposited. The massive graft is applied in the same manner as a metal or beef bone plate except that the cortex of the fragments is freshened to expose fresh bone to provide nourishment for the graft.

## TECHNIQUE

In order to illustrate the method of applying massive graft I will describe the operation as carried out in a typical case of non union of the humerus.

*Incision and dissection.* In operations on the humerus the soft structures particularly the nerve trunks must be molested as little as possible. The musculospiral or radial nerve is particularly liable to injury because of its intimate contact with the bone in the musculospiral groove and its lateral position in the lower third of the

arm. This nerve traverses the arm posteriorly through the musculospiral groove close to the humerus between the heads of the triceps muscle. It comes forward laterally at the outer side of the elbow several inches above the outer condyle in the substance of the triceps muscle and soon enters the supinator longus therefore it can readily be seen that although the lateral approach to a fracture of the humerus is more convenient for the surgeon it jeopardizes the safety of this important nerve. I use an external anterolateral incision (Fig 1a) curving the lower end across the tendon of the biceps. The dissection is carried down between the biceps and the triceps muscles and does not disturb the substance of the supinator longus muscle in which the musculospiral nerve divides into the posterior interosseous (motor) and the radial (sensory) (Fig 1c). When this line of dissection is adhered to the musculospiral nerve is well out of the way.

*Exposure and preparation of fragments.* The bone is exposed the fragments separated (Fig 2a) and the ends forced out through the incision so that the fibrous tissue between them can be removed (Figs b and c). The end of each fragment is sawed off squarely (Fig 3b) and the medullary cavity reamed out (Fig 3a). The ends are carefully fitted together to make sure that the angle at which the bones were sawed off is such as to prevent bowing (Fig 3d). The fragments are prepared for the reception of the massive graft by chiseling or sawing (Fig 3c). A sufficient amount of the cortex on the side (the anterior surface when the external anterolateral incision is used) is removed (Fig 3d) to expose the deeper bone which has a good blood supply. All vessels of any size in the arm are tied and ends of the bone are wrapped in gauze sponges saturated with sodium chloride solution and a small sponge is laid in the wound. The edges of the skin are drawn together by means of a towel clip. No tourniquet is used on the arm for fear of injuring nerves.

*Removal of bone graft.* It is usually better to use the tibia on the same side as the affected arm because if it becomes necessary to use a crutch to relieve the strain on the leg the patient will be able to ambulate more quickly if he can use the crutch with the opposite arm. The bone graft





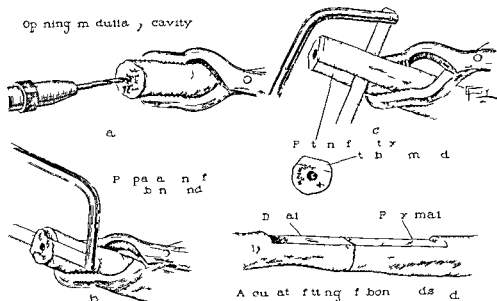


FIG. 3 a Drilling the canal b smoothing the bone ends c removal of the cortical bone d humerus prepared for graft

should be removed from the tibia as close to the upper end of the bone as possible and should include all layers. The end which originated near the epiphyseal line should be placed against the lower fragment because the bone cells near the epiphysis are more active in forming new bone. We know that practically all the growth of long bones takes place at the epiphysis not in the center of the shaft. Before closing the wound after bone grafting operations if it is possible to obtain scrapings with a curette from the epiphyseal area I pack them about the line of fracture. I am sure that our percentage of good results has been increased by the packing of these small grafts properly around the line of fracture. The incision (Fig. 4) is curved to prevent it from coming directly over the site of removal of the graft moreover the distribution of the veins is such that the curved incision causes the least injury to the venous circulation (Fig. 5). Figure 4 shows the leg prepared the tourniquet in place and the bones sketched in outline. The bone can be removed by means of a chisel and drill. The motor saw is quicker and more convenient but it should not be of such high speed

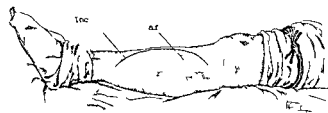


FIG. 4 Showing the relation of the incision to the skin and bones

that it will burn the bone. Figure 6 shows the method of removing the graft and water being dropped on the saw to keep it cool. The graft is removed from the internal surface of the tibia the crest being left intact. Figure 6c shows

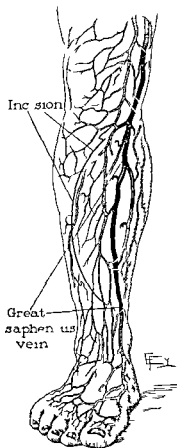


FIG. 5 Showing the location of the incision in relation to the veins

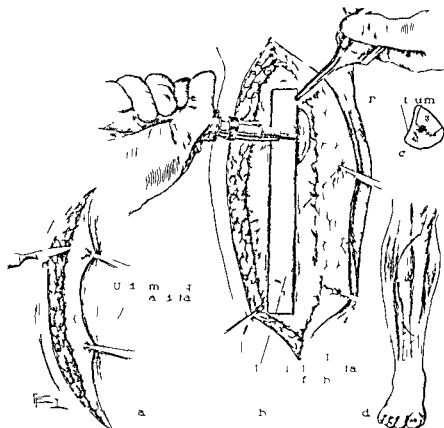


Fig 6 Un! m gth k fl p b g tth g ft ho g l t  
of th g ft d h g th i lat t tl m l

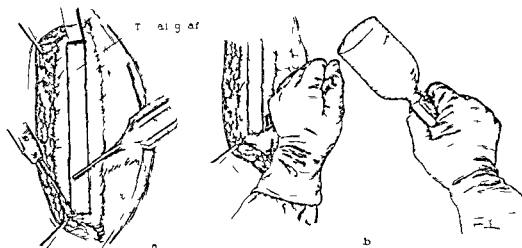


Fig 7 Sh th d ll h le at the e d of the g ft b h l pry go t the g ft

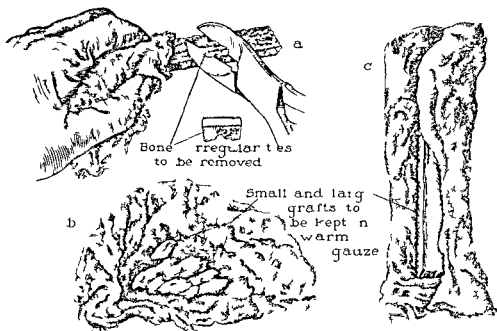


Fig. 8 a Smoothing the inner surface of the graft b and c small pieces of bone and large graft kept in warm gauze

diagrammatically the amount of bone removed. The removal of the graft is facilitated by drilling several holes at each end of the graft and freeing it by means of a chisel (Fig. 7a). Figure 7b shows the chisel being used to loosen the graft at the sides. The uneven pieces of cancellous medullary bone on the under surface of the graft are carefully removed with a bone biter (Fig. 8a) to give a smooth surface so that the graft can be applied to the prepared surface of the humerus. The graft and the fragments should be wrapped in a gauze

sponge and kept warm (Fig. 8b). The wound in the leg is closed and a firm dressing applied over it to prevent the formation of a hæmatoma. The tourniquet is removed.

*Application of bone graft with beef bone screws.* The ends of the humerus are approximated and the massive graft or plate of living bone applied to the prepared area on the fragments (Fig. 9). The ends of the fragments are pushed together firmly and the graft held in place by bone forceps. Means of holding this plate like graft to the

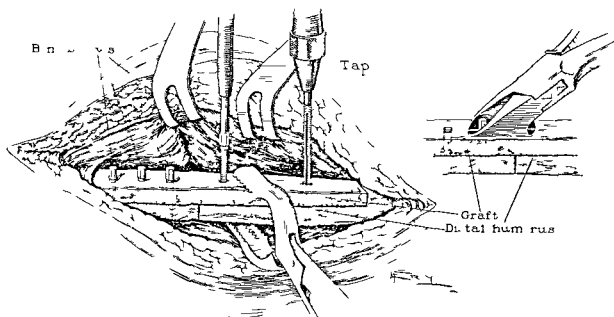


Fig. 9 a Drilling holes and placing bone screws b biting off the head of the bone screws

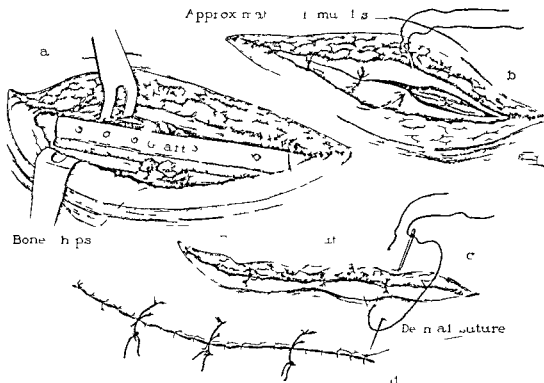


Fig. 1. a. Graft. b. Fixation. c. Denial suture. d. Final fixation.

fragments may be provided by several different methods however I have found that beef bone screws serve the purpose admirably. Autogenous bone screws may be made with a dowel reamer at the cost of considerable time or autogenous pegs may be staggered into the graft and the fragments at various angles according to the method of Willis Campbell but the preparation of these pieces is also time consuming. The use of beef bone screws previously prepared saves considerable time. They are strong and retain their strength until the bone graft has become firmly united to the fragments. They must be made accurately so as to fit the threads that are tapped into the drill holes in the graft and fragments. Screws fitting too loosely are of no use and if they are too tight they bind and break as they are screwed in. Usually two holes in each fragment sometimes three are bored with either an

electric or hand drill through the graft and the fragments until the drill perforates the opposite cortex. After the screws are inserted the heads are bitten off (Fig. 9). Before the wound is closed it is most important to pack multiple small grafts around the line of fracture (Fig. 10a).

In bone grafts for non union or delayed union of fractures of the humerus postoperative fixation is essential. We have found that a body cast encircling the chest either resting securely on the iliac crests or hanging from the opposite shoulder should be applied a few days before operation. Following operation a cast should be applied to the arm forearm and hand extending from the ends of the metacarpal bones to the axilla and should be fastened securely to the body cast by plaster of Paris thrown around the body and arm cast and over the shoulder.

# END-RESULTS FROM CORRECTION OF CYSTOCELE BY THE SIMPLE FASCIA PLEATING METHOD<sup>1</sup>

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A. T. P. f. O b t t. d G y. l g y

**F**EW gynecological subjects have received as much discussion as cystocele the literature abounding with contributions dealing with various phases of the condition. Most of these papers have dealt with the technique of operative procedures, some have emphasized the cause etiology or treatment while only a few have reported end results from corrective operations. Since bulk of literature on a subject is often a bad rather than a good sign, one might well hesitate before adding to it. Yet it is only through this pooling of ideas that we may separate the chaff from the wheat and become familiar with the views, procedures and corrective measures that are most desirable and so arrive ultimately at what may be considered nearest to the ideal.

The writer has long felt that while many operative methods for correction of cystocele give good results yet they are too complicated for general use and furthermore do not give better end results than some of the simpler procedures. In the hands of specialists such complicated methods have indeed a valuable place but it must be remembered that only a small portion of cystoceles are corrected by highly trained gynecologists and it should be apparent that the most satisfactory method will be the simplest procedure giving good results. With this idea in mind the writer decided to study the end results of the simple fascia pleating operation which is probably much the same method as is used throughout the country with minor variations common to the individual clinics and operators.

One hundred and fifty patients operated upon at the University Hospital by this simple fascia pleating method from 1920 to 1936 were studied the period since operation varying from 1 to 6 years. Each patient's record was carefully studied with particular reference to complaints which might have been produced by the bladder lesion. All of the patients were then interrogated by means of a questionnaire in order to verify their original entrance complaints to determine the results of the operation and if possible to ascertain their present condition. However only one hundred answers were received but in practically every instance the response was prompt and the answers were very concise and to the point.

To permit the better judging of the results obtained the method of correction used may be briefly described as follows. The cervix was grasped with a vulsellum forceps in the center of the anterior lip and pulled downward. A transverse incision  $1\frac{1}{4}$  to  $1\frac{1}{2}$  inches in length was made transversely across the anterior lip of the cervix just below the lowest point of bladder attachment (Fig. 1). Two Allis clamps were placed on either side of the midline of upper free edge (Fig. 2) and traction was exerted downward. The tip of a scissors was inserted between the mucosal and fascial layers. This was easily accomplished when the index finger of the left hand was placed on the outer surface of the mucosa and pressure made up against this finger with the scissors. The line of cleavage was very distinct and once found the scissors were pushed without difficulty up toward the urethra between the mucosal and fascial layers (Fig. 3). The blades of the scissors were separated and the scissors withdrawn and the separated mucosal layer incised in the midline up to within  $\frac{1}{2}$  inch of the urethra (Fig. 4). The mucosal layer was dissected laterally, each side being freed from the underlying fascial structures. This dissection was carried out as far as the lateral walls of the vagina on each side (Fig. 5). The bladder was then pushed up to a point beyond the region of the internal cervical os of the uterus. It was occasionally necessary to use sharp dissection to commence this displacement of the bladder but generally blunt dissection was sufficient. Carrying the dissection as high as the internal cervical os was important since we felt that in fixing the pubovesicocervical fascia at this high point the foreshortening of the anterior wall of the vagina would tend to prevent rather than produce backward displacement of the uterus. This completed the fascia overlying the bladder was pleated vertically by means of a continuous No. 1 chromic catgut suture which was started at the top and carried down toward the cervix the lower edge of the fascia being stitched to the cervix at the region of the internal cervical os. The pleating was then completed the same suture being carried back up to the starting point. In general no further pleating was necessary except in the larger type of cystocele when one or two additional pleatings

occasionally seemed advisable. The excess mucosa from either side was then trimmed off and the edges approximated with absorbable interrupted sutures, care being taken to pick up some of the underlying fascia in order to prevent the formation of dead space. It is obvious that this folding or pleating of the fascia as described throws the base of the bladder into folds but this apparently does little if any harm. The operation outlined fulfills the requirement of being simple and from data obtained in this study is eminently satisfactory in so far as results are concerned.

In some instances other operations were performed at the same time: thus most patients had a perineorrhaphy, some a trachelorrhaphy, others had a laparotomy for hysterectomy, for suspension of the uterus or for appendectomy. The influence of these additional procedures upon the end results of the cystocele repair will be considered later.

#### SYMPTOMS ON ADMISSION

All complaints on admission to the hospital were carefully checked over and the frequency of each is shown in Table I. Backache, a common complaint in women, was included simply to note whether any relation existed between this symptom and the size of the cystocele.

TABLE I—SYMPTOMS ON ADMISSION

Symptom	C	F
Frequent urination	63	63
Dysuria	54	54
Burning	5	5
Incontinence	43	43
Pruritus	8	8
Bleeding	8	8
Bladder prolapse		
Retention		
Not noted		

Frequency, dysuria and burning are commonly associated with bladder disease of all types and for that reason are probably of no particular interest except in relation to the end results.

Incontinence is seen to be a particularly common symptom and it is of interest to note that this complaint was quite generally distributed regardless of the size of the cystocele or the age of the patient. Of the 3 patients operated upon for enormous cystoceles, 2 complained of incontinence. This number is so small, however, that no conclusions are possible. In all other groups regardless of size, this symptom was fairly common, many patients noticing it on coughing, sneezing or laughing, while others were incontinent even without straining.

Eighteen patients complained of backache. Of these, 1 had a definite lumbosacral arthritis and 1 a sacroiliac arthritis. Both of these patients were treated orthopedically and relieved of this symptom. Five of this group with a marked retroversion of the uterus were operated upon for this condition as well as for the cystocele. Four were completely relieved while 1 complained of an occasional backache but was otherwise improved. Of the 11 remaining cases who had no apparent disease to account for their backache, 8 were reported as being completely well in all respects after correction of the cystocele while 3 still had occasional trouble. While 18 per cent of the women studied complained of backache, it is difficult to determine the actual relationship existing between this symptom and cystocele. The fact remains, however, that out of 11 patients with backache and no demonstrable disease other than the cystocele and lacerations to account for it, 8 were completely cured and 3 were improved by simple correction of this pelvic lesion.

The size of the cystocele was noted in all instances at the time of examination or operation and was classified as follows: enormous, the size of an average orange; large, the size of a lemon; moderate, the size of a hen's egg; small, the size of a bantam's egg or plum. On this basis, the 100 cases grouped themselves as in Table II.

TABLE II—SIZE OF CYSTOCELES TREATED

Size	C
Enormous	3
Large	5
Moderate	4
Small	4
Total	100

This classification was of value in many respects, principally, however, in that it permitted the study of symptoms and end results in relation to the size of the cystocele. The best results were obtained in the larger lesions. Small cystoceles were noted in 6 of the 7 cured cases (36 per cent) in 10 of the 22 patients who were only improved (45 per cent) and in 5 of the 6 failures (83 per cent). Just why the results should be better in the larger cystoceles cannot be automatically stated. Possibly more painstaking care was exercised in the larger lesions or, on the other hand, the symptoms attributed to the small cystocele may have originated from another source and so were not relieved with repair of the cystocele. The relative frequencies of the symp-

toms in relation to the size of the cystocele are shown in Table III

TABLE III—RELATION OF SIZE TO FREQUENCY OF SYMPTOMS

	E m P			L g P			M d P			Sm ll P		
	N	t	N	t	N	t	N	t	N	t	N	t
Number	3		15		40		42					
Frequency	3	100	9	60	8	70	23	54	7			
Dysuria	3	100	6	40	23	57	5	2	52	3		
Burnin <sup>g</sup>	2	66	6	40	17	42	5	6	61	9		
Incontinence		66	6	40	16	40		19	45	2		
Protrusion		66	6	5	33	8	0	3	7	1		
Backache	1	33	3	13	3	6	15	9	21	4		

#### RESULTS OF OPERATION

Ninety four of the 100 patients studied reported themselves as perfectly well or definitely improved. Seventy two said they were perfectly well while 2 were definitely improved but did not consider themselves perfectly well and 6 stated they were no better after the operation. Complete cure in 72 per cent of the cases and definite improvement in an additional 2 per cent is certainly a sufficiently satisfactory showing to justify this method of repair.

#### INTERVAL SINCE OPERATION

Inasmuch as considerable time has elapsed since the operation in some instances 6 years this time element must be considered. The curative power of time is well known and its importance in this study is difficult to estimate. Table IV shows the results obtained in relation to years since operation.

TABLE IV—YEARS AFTER OPERATION IN RELATION TO CURES AND FAILURES

	C			Imp			I		
	N	t	N	t	N	t	N	t	N
One year after operation	7	58	3	5	2	16	6		
Two years after operation	3	75	1	25					
Three years after operation	21	75	7	25					
Four years after operation	15	75	4	0	4	1	5		
Five years after operation	18	66	6	7	25	9	2	7	4
Six years after operation	8	88	8		1	11	2		
Total	72	72	22	22	6	6			

#### COMPLETE CURES

The incidence of cures shows definite evidence in favor of the greater curability of the larger lesions. We see that the larger the cystocele the better the chances for complete relief. Thus cures were obtained in all (100 per cent) of the enormous cystoceles and in 12 (80 per cent) of the group classified as large but in only 31 (77.5 per cent) of the moderate and 26 (61.9 per

cent) of the small lesions. To be sure there were more of the latter treated and it is possible that this may partially account for the difference in percentage of cures but it seems that other factors must play an important role. It may be that in the larger cystoceles the removal of the visible tumor aids in convincing the patient that she is well. Moreover we may be misled and blame a small cystocele for symptoms of another origin. Table V shows the relation between results obtained and size of the cystocele.

A study of the patient's age with relation to results is shown in Table VI. It will be noticed

TABLE V—RESULTS IN RELATION TO SIZE OF CYSTOCELE

	F m P			I g P			M d P			Sm ll P		
	N	t	N	t	N	t	N	t	N	t	N	t
No of cases	3		15		40		4					
Cures	3	100	1	80	31	77	5	26	61	9		
Improved			2	13	2	9	5	11	26	1		
Failures			1	6	6		5	11	9			

TABLE VI—RESULTS IN RELATION TO AGE OF PATIENTS

	T t d			C d P			Imp			N m P		
Ag	G	P	N	t	N	t	N	t	N	t	N	t
20-25 years	8	5	62	5			5		1	12	5	
26-30 years	3	10	76	9			15	3	1	7	6	
31-35 years	15	7	46	6	40		23		2	13	3	
36-40 years	3	10	76	9			23					
41-45 years	14	9	64	2	5	35	7					
46-50 yrs	23	18	78	2	3	13		2	8	6		
51-55 years	8	7	87	5	1	1	5					
56-60 years	5	5	100									
61-65 years												
66-70 years	1	1	100									

that the percentage of cures increased with the age of the patient. Thus the lowest percentage 46.6 per cent was at ages 31 to 35 while at 41 to 45 years the percentage of cures was 64.2 per cent at 46 to 50 years 78 per cent at 51 to 55 years 87.5 per cent and at the ages of 56 to 70 years it was 100 per cent.

#### IMPROVED BUT NOT COMPLETELY CURED

Of the 2 patients who were improved but not definitely cured 10 or 45.4 per cent gave incontinence as the only reason for considering themselves not completely relieved and 3 or 13.6 per cent had incontinence plus other bladder symptoms. Thus over one half of the improved patients had a residual incontinence. It is possible that some of these patients could have been cured had more care been taken in plying the fascia in the region of the neck of the bladder.



The use of a mattress suture in this region preliminary to the plecting proper as mentioned by Neel (4) should be emphasized particularly in cases giving incontinence as one of their entrance complaints.

Table VII shows the number of patients reported as improved and enumerates the residual symptoms.

Incontinence stands out as the symptom most likely to remain after the operation. Forty-three patients had this symptom on admission and 8 of these or 6 per cent were cured. Thirteen of the improved and 1 of the non-improved patients complained of incontinence after the operation, this being the principal cause for imperfect cure in the improved group.

TABLE VII—CASES IMPROVED ONLY

I		P	d	l	y	m	C	P	t
I	t	n	l	y	d	b	f	i	y
								45	4
B		k	l	f	q	v	l	3	7
S		l	d					5	7
F		q	y					4	5
S		p		t	m	p	d	4	5
P				b	l	d		4	5
I				l	l	s	t	4	5

## FAILURE

Six patients stated they were no better following the operation. In five instances the reasons given for the disappointment seem hardly valid since there were absolutely no bladder complaints. In another the result of the operation was perfect for 13 months at which time confinement caused a recurrence of the cystocele and the original complaints (Table VIII).

TABLE VIII—FAILURE

B		k	h	f	l	v	l	d	y	u
P	f	l	l	t	l	l	l	b	n	3
		p	t	C	t	l	d	y	m	p
F		l						d	y	l
N		b	l					l	t	l
C		t	m					l	l	g
C		t	m					l	l	g
I		t						l	l	g
		b	l					l	l	g
T		l						l	l	g

It is obvious that the complaints given by 2 patients with cancer of the cervix the other with gastrointestinal symptoms can hardly be attributed to failure in curing the cystocele. Moreover 1 patient had been perfectly well for 13 months when the lesion returned following

confinement. These cases cannot be classed as primary failures although in studying end results they must be so grouped. A corrected list of failures would show 3 or 3 per cent.

The fact that more patients did not have trouble after the operation is particularly interesting when we consider the work of Brown and Pauls ( ). These investigators made cystoscopic studies of the bladder condition in 49 patients after operation for cystocele. Although this study was not confined to the results of any one procedure it was shown that visible folding of the base of the bladder was common following such operations. From the results of our study it seems doubtful whether this bladder distortion is particularly important in the production of symptoms later on. Certainly the base of the bladder must be folded in all operations based on plecting of the pubovesicocervical fascia. A comparison of these end results with those obtained in patients operated upon by the fascia overlapping procedure as advocated by Neel (4) Spaulding (7) Pauls (5) and others would be particularly interesting in this connection. In the latter operation there should be little if any bladder distortion provided the fascial dissection is carried out sufficiently toward the lateral walls of the vagina. This overlapping procedure is frequently used in our clinic with very good results but the number of cases operated upon up to the present time is not sufficient to permit a comparison.

That the end results are better in the larger cystoceles is further evidence to show that folding or distortion of the base of the bladder is unaccompanied with serious consequences. Certainly the degree of folding or distortion of the bladder base and ureters must be considerably greater in the larger lesions where the amount of plecting is necessarily more than in a small cystocele.

## RETROVERSION FOLLOWING OPERATION

The question of retroversion following the operation is an important one since no procedure can be considered satisfactory if in correcting another lesion is produced. Many operators make it a point to perform a suspension operation whenever a cystocele is repaired. In our clinic this has been done only when a marked retroversion was found at the time of operation. Accordingly the suspension operation was necessary in only 5 of the 100 cases. As previously mentioned the fixing of the lower edge of the plicated fascia at least as high as the internal cervical os was insisted upon. By this maneuver we hoped not only to raise the bladder but also to prevent the occurrence of postoperative retroversion due

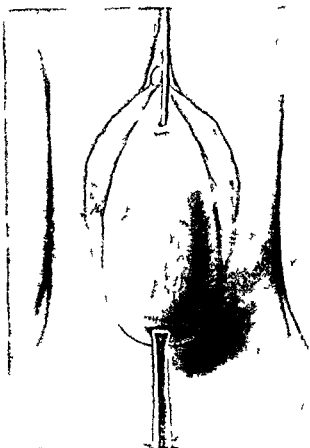


FIG. 1. Showing how the cervix is pulled down. The uterine sound in the bladder shows the extent of the cystocele.

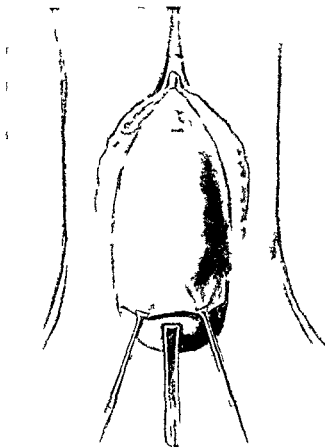


FIG. 2. Showing the transverse incision just below the bladder reflexion. (Compare with Figure 1.) Clamps have been placed on the free edge of the mucosa.

to foreshortening of the anterior vaginal wall Neel (4) suggested that the lateral mucosa with the underlying fascia be advanced to the midline of the cervix and sutured in that region as a means of preventing the tendency toward posterior displacement. In this series 3 patients had a retroverted uterus at the time of their discharge examination. Since it was impossible to get these patients to travel from various points in the state back to the clinic for follow-up examinations it is impossible to say how many more developed retroversions at a later postoperative period. The fact that only 3 cases showed displacement nearly 3 weeks after the operation however may be taken as evidence that this occurrence is not common. We would expect

most displacements to appear during the first few weeks although it is possible that some occur later as a result of scar tissue formation and contraction. If by this procedure we also lessen the chances for retroversion as we feel we do then it has an added advantage over those procedures in which laparotomy for suspension is necessary.

#### POSTOPERATIVE MORBIDITY

The various reasons for the postoperative fevers occurring in this group are shown in Table IX. Any temperature over 100.4 degrees for 2 or more consecutive days was considered as definitely febrile. The uncorrected morbidity rate was fairly high due largely to 4 infected laparotomy wounds (in instances of combined operations) which can scarcely be included in a morbidity study of a specific cystocele operation. Some patients showed a slight separation of the mucosal edges without evidence of infection and were kept in the hospital a few days longer until complete union had taken place. Only 1 infected perineum was noted in the entire 100 cases and this occurred in a patient suffering from diabetes mellitus. The morbidity rate for cystocele correction

TABLE IX. — POSTOPERATIVE MORBIDITY

C	H	C
Infected perineum (diabetic)		1
Infected laparotomy wound		4
Pyelitis		1
Trichomonas bladder infection(?)		1
Lung infection(?)		1
Cause undetermined		3
Total		11

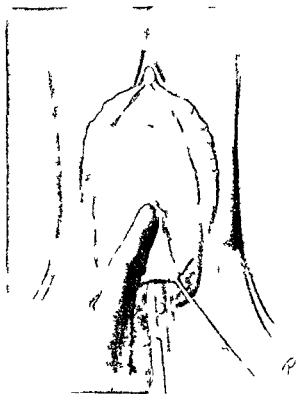


Fig. 3. S. r. h. b. t. d. d. l. t. t. l.  
m. d. th. f. Th. l. ft. l. f. g.  
ll. t. g. d. f. t. All. f. mp. f. l. tat.  
th. t. p.

should be very low since drainage from the operative field is good, the blood supply excellent and infections in this region are not particularly common.

#### CONVALESCENCE

Each of the 100 patients studied was asked how long a time had elapsed after the operation before relief was noted. Twenty-four were relieved immediately or within the first few weeks after the operation while in 9 cases improvement was noticed between the first and second month after operation in 26 after 3 to 6 months and in 5 after 6 months to 1 year. Thirty or 30 per cent reported having been gradually relieved while 6 were not improved.

Doubtless many factors tend to vary the time needed for recovery, such as the size of the cystocele, the severity of symptoms previous to operation, the age of the patient and no doubt the environment into which she goes on returning home as well as the actual operation all of which must be considered in this connection. When a laparotomy has also been performed the convalescence may be prolonged due to greater

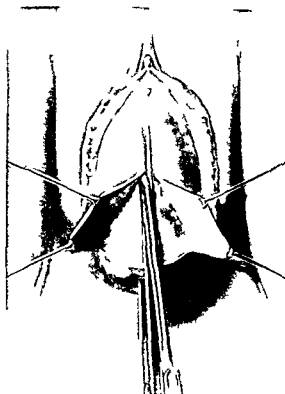


Fig. 4. I. f. the muc. l. l. y. r. h. h. p. ou. ly.  
b. p. t. d. fr. m. th. nd. ly. f. ca.

drain on the patient's physical resources. A few too must play a part. Our youngest patient was 29 years of age and the result was excellent with only a few weeks required for complete disappearance of all symptoms. On the other hand the oldest patient was 69 and the result was excellent after 2 months. The average age was 41 years. While syphilis, diabetes, cardiac or renal disease may also be a factor in determining the end results as well as the duration of the convalescent period, such complications were not common. One patient had a positive Wassermann reaction and was intensively treated previous to operation while another was a diabetic. Neither was completely cured, each complaining of some bladder disturbance. In neither instance was the healing particularly delayed although the diabetic had a mild postoperative infection of the perineum.

#### EFFECT OF LAPAROTOMY ON END RESULT

It seemed that the removal of uterine fibroids or pus tubes and the correction of uterine displacements would insure better results in the cystocele operation but our findings indicate that such combinations are in fact detrimental and

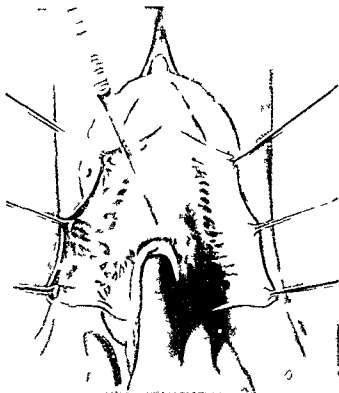


FIG. 5. Shown the mucosa incised up to within one half inch from the urethra. Flap separated from underlying fascia to lateral walls of vagina. The bladder and its fascial covering are being separated from the cervix and pushed up to a point beyond the internal cervical os.

that patients operated upon for cystocele with out the necessity for laparotomy have a better chance of perfect cure.

Table V shows the types and numbers of the 51 abdominal operations performed in the various groups of patients. Only 17 were among the 72 patients recorded as cured (23 per cent) and 10 among the 2 improved cases (45 per cent) while of the 6 failures 4 (66.6 per cent) had a combined operation. It would thus appear that combining plastic and abdominal work has a distinctly detrimental effect upon the former.

#### SUBSEQUENT PREGNANCIES

Twelve patients reported having been confined since operation. Eleven deliveries were normal and only one patient had a recurrence of the cystocele with symptoms (8.3 per cent). This patient aged 39 years was perfectly well for the 15 months following her operation and preceding the confinement. Following delivery which was normal the cystocele and original symptoms apparently returned. The size of the baby at the time of birth was not known. The operative confinement was a cesarean section at 1½ months for toxæmia of pregnancy. The fact that this patient had previously had a normal deliv-

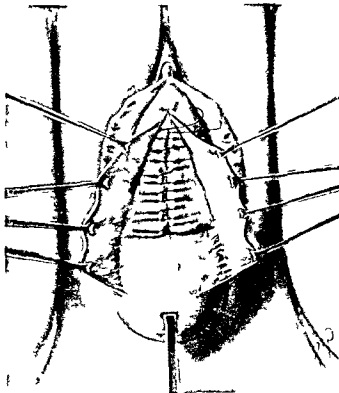


FIG. 6. Plication of the pubovesicocervical fascia (fascia overlying the bladder). Note the point of fixation to the cervix at the lower angle of the plicated fascia.

TABLE V.—LAPAROTOMY COMBINED WITH CYSTOCELE REPAIR

Operation	Number of failures			Total
	Combined	Improved	Not improved	
Radical Wertheim 3 weeks after repair of the cystocele				1
Carcinoma as found in piece of cervix removed at time of cystocele operation				
Subtotal hysterectomy for fibroid	4	1		5
Subtotal hysterectomy and salpingectomy for inflammatory disease		1		3
Anterior suspension with appendectomy		3	3	8
Anterior suspension only	7	4		11
Appendectomy only	1	1		2
Closure of perforating wound of uterus			1	1
Total	17	10	4	31
Percent	36	44	66	

ery would indicate that in all probability she would be grouped with the normally confined were it not for the toxæmia treated by cesarean section. One of the group had a stillbirth. This patient aged 39 was perfectly well following operation. One year later when 3 months pregnant she was operated upon elsewhere at which time a myomectomy and appendectomy were



## A METHOD FOR THE GRADUAL OCCLUSION OF THE AORTA

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**O**CCCLUSION of the aorta has been performed in man in 2 instances. This daring operation was usually undertaken for the cure of aneurism of the abdominal aorta. Though in some instances the patient was cured of the aneurism, he usually succumbed from secondary hæmorrhage due to a cutting through of the occluding device. From the time the aorta was first ligated by Sir Astley Cooper (1) in 1817 to the present there has been no method of procedure to secure occlusion of this structure which does not subject the patient to grave danger of death. The surgeon is confronted with a curable disease which is certainly fatal if untreated, yet which must be avoided surgically because of a lack of a proper method of procedure. A suitable method must have several attributes: (1) it must avoid secondary infection such as occurs with clamps or snares which protrude outside the skin; (2) the occlusion must be gradual in order to allow compensation of the circulation; (3) finally compression of the arterial wall must be avoided since the expansile pulsation quickly weakens this structure and rupture follows.

A method is described which embodies all these principles and in addition is relatively easy of technical performance.

## HUMAN CASES

Clinical experience in this field is relatively limited but very illuminating. Fourteen of the 22 cases died within 3 days from shock or circulatory derangement as a result of sudden occlusion. Two cases survived the effect of ligation but died in 10 days and 48 days respectively from secondary hæmorrhage. In all of the remaining 6 cases a method of gradual occlusion was used and these patients survived from 41 days to over a year. In addition there are 3 cases in which internal suture of the aneurism was attempted. All patients died from hæmorrhage within a few hours since the aortic wall would not hold the sutures well. From these cases it may be stated that:

- 1 Sudden ligation of the human thoracic or abdominal aorta is usually a fatal procedure.
- 2 Suture of the diseased wall is unsatisfactory.
- 3 Gradual occlusion is the only hopeful method.

The best procedure for gradual occlusion thus far devised is the Halsted aluminum band. That

this is not satisfactory for use on the human aorta may be judged by Halsted's (10) words: "I have applied an aluminum band to the human aorta 4 times, twice in one subject and twice with promising results so far as the cure of the aneurism is concerned. But the experimental work on animals had led me to expect that ultimately the metal bands must cut through the artery because in cases observed 7 months or less the wall of the aorta had become atrophied to the thinness of paper and there was no adhesion between the infolded attentuated surfaces. That my fears were well founded was proved by an experience in Europe about 18 months ago. The patient was an aged woman with dilated and badly functioning heart. The large aortic aneurism was well located for the placing of a band which was applied just below the renal vessels. Within a few days the aneurism, which before operation was distinctly visible from the seats of the operating amphitheater, was barely discernible at the bedside and at the end of 6 weeks had disappeared so completely that the patient was discharged apparently cured. But walking out of the door of the hospital she was seized with a pain and returned to her bed. The following morning she died from hæmorrhage. The aorta had ruptured at the site of the band but the aneurism was found to be nearly cured. Thus the search for other procedures is justifiable."

## EXPERIMENTAL RESEARCH

During the century following the first case of ligation of the aorta in man, much experimental work was done regarding it. The two main objects of this work were to determine the effect of ligation on the organism and to devise a successful mechanical means of carrying out the procedure. Pirogoff (19), Sonnenburg (3), Kast (12) and Kuemmell (15) showed that ligation of the aorta was a feasible procedure in animals that it caused no harm to the heart and lungs and that the peripheral circulation quickly returned. Allen (1) found that partial occlusion of the abdominal aorta with an aluminum band followed in about 10 days by ligation causes no apparent disturbance to the animal.

The collateral channels have been demonstrated by Porta (6), Kast (1) and more recently by Reichert (1).



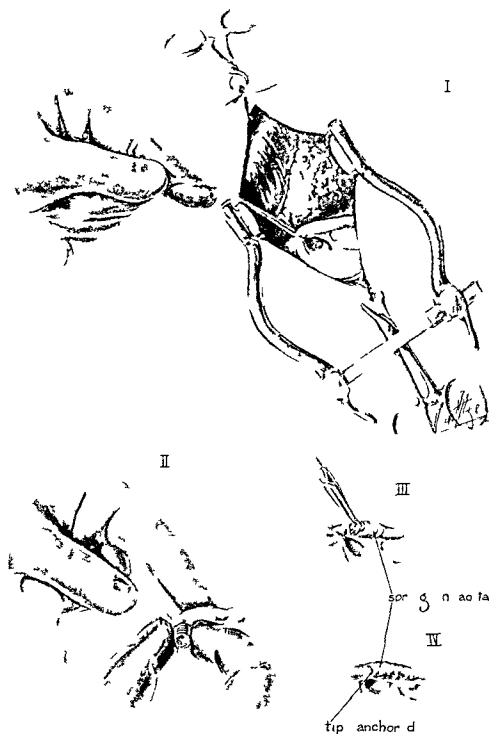


FIG. 2. The technique of introducing the spring. *I* the thoracic aorta exposed. *II* the tip of the spring thrust into the lumen. *III* the spring turned parallel to the artery and introduced by rotation. *IV* after introduction.

is not the case with dogs. Further, in those human patients surviving the occlusion, the majority died later from hemorrhage due to cutting through of the occluding device. This rarely occurs in the abdominal aorta of dogs. But on the other hand, animals do not tolerate sudden oc-

clusion of the thoracic aorta and any partially occluding device applied to this structure usually results in death from secondary hemorrhage. Reid states: "Partial occlusion of the thoracic aorta with bands or ligatures cannot be done either in man or dogs without grave danger of





Fig. 1. The effect of the ligature.

The majority of the experiments on animals were done on the abdominal aorta below the origin of the renal arteries.

The experiments to obtain a proper mechanical means for occluding the aorta have been numerous and many ingenious devices have been conceived for this purpose. The earliest attempt to avoid the sudden shutting off of the circulation in this great vessel was by means of a rubber tourniquet which encircled the abdomen and compressed the aorta from without. This was occasionally followed by trauma to the abdominal viscera and rupture of the intestines with unheard of results. Because of this fact Miltner (11) suggested a rubber tourniquet which went over the aorta and out on either side of the spine so that it might be tightened at will without trauma to the viscera. This was never attempted in man.

The next step was the use of a metal clamp or snare of silk, catgut or metal which protruded from the abdomen and was tightened or loosened from the outside. Such instruments have been devised by Keene (13), Stratton (24), Dubois (8), Assolini (3), Burjalsky (4), and Cooper (6). All had a common purpose, that of gradual occlusion of the aorta and all had a common fault, namely, liability to secondary infection. Dr. Halsted (10) in a preliminary report on the use of his aluminum bands said: "The notion of gradual compression in the ordinary use of the term was entertained only to be definitely discarded because of the seemingly insurmountable difficulty of preserving asepsis. A sinus must form about any instrument leading from the aorta to the air and sooner or later such a sinus necessarily becomes infected. This objection is an important one for in few fields is asepsis so essential as in vascular surgery. Infection uniformly predisposes to secondary hemorrhage."

The next contribution was one of the most important steps in the surgery of the great vessels, namely, the introduction of the partially occluding band by Halsted (10). He showed that a

partially occluding aluminum band applied to the abdominal aorta of a dog would eventually result in complete obliteration and this was called the ideal closure. It has been mentioned that Halsted was not entirely satisfied with his band for use on the human aorta. However, it has been of great value not only for use in situations in which sudden obstruction is dangerous, such as with the innominate, subclavian, carotid, femoral or popliteal arteries, but also in the elucidation of the principle of aseptic gradual occlusion of the great vessels. Thus, it has served its purpose well.

Halsted also tried ligatures, tapes and tissue bands to occlude the aorta. He says: "Fine silk cut through in a day, coarse silk cut through more slowly. Knotted ligatures were found to be unsuitable for a desired degree of constriction or obliteration could not be accurately obtained nor could the crushing of the arterial wall be invariably avoided. Tapes of various materials were tested—of cotton, of chromicized intestinal substance, of elastic tissue obtained from the aorta, of aponeurotic white fibrous tissue. These were applied in spiral or cuff form. These tissue bands always relaxed and allowed reestablishment of the lumen. Hacker (9) and Holman (11) have given additional proof that encircling partially constricting sutures or ligatures are almost invariably followed by fatal secondary hemorrhage."

One of the most promising investigations on this subject was contributed by Matas and Allen (16). The authors brought about constriction of the thoracic aorta in 151 dogs by plication mattress sutures. The plication was increased at subsequent operation and in some instances the lumen was almost obliterated. Reid (2) has recently confirmed these observations. But it has been stated that in the 3 cases in which suture of the diseased arterial wall was attempted in the human, the patients died of hemorrhage. The stitches would not hold.

Thus, the methods for occluding the aorta are clamps or tourniquets which protrude from the wound, ligatures, partially occluding tapes, fascial or metal bands, and sewing of the arterial wall. None of these methods is entirely satisfactory for the purpose.

#### EXPERIMENTAL METHOD

There are certain facts stated above that are worthy of note by those interested in interpreting experimental work on this problem for use in the clinic. It has been observed that two thirds of the cases of sudden occlusion of the human abdominal aorta resulted in death from shock. This

sion of about 4 inches was made over the eighth intercostal space. This was carried down through the intercostal muscles all bleeding points were clamped and ligated and the chest was opened. The pleura over the thoracic aorta was picked up and incised and the arterial wall exposed. A type carried by an aneurism needle was passed under the artery and used for traction (Fig. 2). The aorta was gently lifted and steadied with the left hand. This procedure results in a partial obstruction of the lumen with consequent proximal distention of the artery that greatly facilitates the introduction of the spring. The coiled wire was grasped with the right hand the sharpened tip thrust into the lumen and the spring rotated 1 or 2 turns to hold it in place. It was then grasped with a clamp turned parallel to the arterial wall and introduced by rotation until only a small tip remained outside the lumen. This was left in place and served to anchor the device and prevent hemorrhage through the perforation. The first step was accomplished without hemorrhage. In some cases when the spring was turned parallel to the artery the perforation was stretched so that a small jet of blood under high pressure escaped. If this was disregarded and the tip of the spring left out a moment's pressure with a sponge stopped all bleeding. The entire procedure has been carried out without completely soiling one sponge. As a rule 3 or 4 sponges were used but the bleeding is no more than that caused by the incision in the thoracic wall.

#### EXPERIMENTAL RESULTS

At the time of the insertion of a metal spring into the thoracic aorta the proximal and distal pulse is the same. Within 15 minutes the pulse proximal to the spring is slightly diminished. At the end of 30 minutes a well marked thrill is present which increases in intensity to a maximum in approximately 1 hour. If the peripheral (femoral) blood pressure is recorded during this stage it is found that the systolic pressure falls and the pulse pressure is diminished. The fall in systolic pressure is not marked until complete occlusion occurs at which time it drops suddenly only to rise gradually as the collaterals dilate.

It was found that the time required for complete occlusion varied in different animals and with various procedures. Trauma accelerates the thrombus formation and is to be avoided. The research of Aschoff (2) has shown that the platelets which form the framework of a thrombus are apt to be deposited in the eddy below an obstruction. A spring consisting of a series of small elevations will produce multiple small eddies

along the arterial wall and the resultant thrombus will have many points of origin. Hence the number of coils in the spring and the size of the wire will influence the rate of thrombus formation and consequently the rate of obliteration of the lumen. Welch (5) in his exhaustive monograph points out that the character of the surface may alter the process of thrombosis. He shows that a smooth non adhesive wall gives poor attachment for the platelets and conversely that irregularities promote the process. In view of this fact any indentations on the smooth surface of the wire would tend to accelerate the obliteration. It is of interest to note that different metals apparently influence the rate of thrombosis. It was thought that copper and brass produced thrombi most quickly. Steel springs result in a slower thrombotic process than do those of brass or copper while surgical silver wire was the slowest of all metals to produce obliteration. Silver plated steel springs are midway between the latter metals. Further experiments to test this point are to be conducted for if subsequent results confirm the present impression then surgical silver wire which is commonly used for the wiring of aneurisms is the poorest metal for the purpose. For the present work either polished steel or silver plated steel springs were adequate. The rate and amount of thrombosis caused by these metals gave obstruction of the lumen slowly enough to be tolerated by the animal.

Following completion of the operative procedure the dog has an uneventful recovery from the anesthetic. There is no indication of air hunger so commonly seen after too sudden obstruction of the thoracic aorta. The femoral pulse becomes slight and completely disappears in about 6 hours. For a period of about 3 days there is apt to be slight weakness of the hind legs. The animal then appears to be perfectly normal and is able to run for a short distance without fatigue.

The fate of the thrombus produced in this manner is important in determining the end result. It is not generally appreciated that a thrombus is most essential for hæmostasis with or without the use of a ligature. Kocher (14) believed it to be the most important factor in the immediate and final suppression of hæmorrhage. The size and shape of a thrombus which had just previously caused complete obstruction is shown in Figure 3. It is to be expected that thrombi in the aorta will eventually canalize how soon and how much this occurs is the deciding issue. From the examination of a series of specimens it was found that canalization of any consequence begins in from 4 to 6 weeks a lapse of time ade-

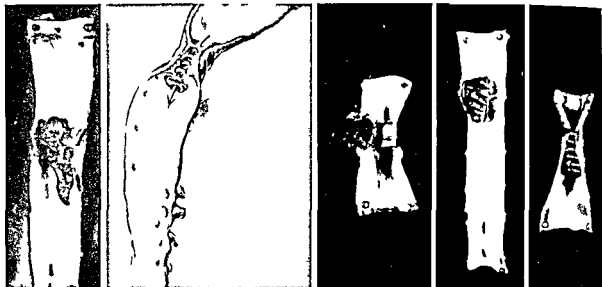


Fig. 1. Thoracic aorta with device applied. Fig. 2. Lateral view of thorax showing aorta. Fig. 3. Thoracic aorta with device applied. Fig. 4. Thoracic aorta with device applied. Fig. 5. Thoracic aorta with device applied.

Fig. 6a. Thoracic aorta with device applied. Fig. 6b. Thoracic aorta with device applied. Fig. 6c. Thoracic aorta with device applied. Fig. 6d. Thoracic aorta with device applied. Fig. 6e. Thoracic aorta with device applied.

fatal hemorrhage. Here the great pressure of the blood and the scant periaortic support hasten death of the arterial wall and prolong the period of repair with fibrous connective tissue.

Therefore occlusion of only the thoracic aorta of the dog is comparable to that of the human aorta throughout its extent. In testing the value of an occluding device it is obligatory to use the animal's thoracic aorta; erroneous interpretations may thus be avoided. This has a further advantage in that since sudden occlusion results in death the efficiency of the gradual occlusion may be determined by the life of the animal.

All previous methods of arterial occlusion have depended upon compression of the arterial wall from without. Experience has shown that compression is not feasible when applied to the aorta since the great expansile pulsation thrusting against the compression agent causes the arterial wall to weaken and rupture. There is however a natural mechanism for occluding arteries that has never been put to use, namely thrombosis. Petit (18) first showed that this is nature's method of controlling hemorrhage.

It is conceivable that if the thrombus could be easily produced and adequately controlled it would be an ideal method for gradual closure of the aorta. It was thought that if metal or glass tubes of various lengths and diameters were placed in the lumen of the artery the thrombotic process could be controlled so as to give a gradual

complete occlusion. The technical difficulty of this procedure is great. The artery must be opened between rubber shoe clamps, the tube introduced and tied in place. This procedure may produce obliteration of the lumen but it is too difficult for practical use. In this regard it is of interest to recall experiments of Carrel (5) who reports 10 instances of intubation of the thoracic aorta with glass or aluminum tubes. Most animals died a few days after the operation and despite careful preparation of the tubes with paraffin a thrombus was usually formed in them. One dog lived for 3 months and the tube remained patent. Carrel interprets this to show that aortic blood can flow through a glass tube for more than 3 months without the occurrence of an obliterative thrombus. However it is not improbable that a thrombus had been formed and was eventually resorbed.

It was conceivable that a metal tube consisting of coiled wire like a spring (Fig. 1) could be screwed into the lumen through a small perforation in the arterial wall. This was tried experimentally and found to be satisfactory in every respect.

#### OPERATIVE PROCEDURE

Adult dogs who received 4 grain of morphine and ether anesthesia by tracheal insufflation (Meltzer Auer Method) were used in every case. The animal was placed on the right side and after the usual skin disinfection and draping an incision

sion of about 4 inches was made over the eighth intercostal space. This was carried down through the intercostal muscles, all bleeding points were clamped and ligated and the chest was opened. The pleura over the thoracic aorta was picked up and incised and the arterial wall exposed. A tape carried by an aneurism needle was passed under the artery and used for traction (Fig. 2). The aorta was gently lifted and steadied with the left hand. This procedure results in a partial obstruction of the lumen with consequent proximal distention of the artery that greatly facilitates the introduction of the spring. The coiled wire was grasped with the right hand, the sharpened tip thrust into the lumen and the spring rotated 1 or 2 turns to hold it in place. It was then grasped with a clamp, turned parallel to the arterial wall and introduced by rotation until only a small tip remained outside the lumen. This was left in place and served to anchor the device and prevent hæmorrhage through the perforation. The first step was accomplished without hæmorrhage. In some cases when the spring was turned parallel to the artery the perforation was stretched so that a small jet of blood under high pressure escaped. If this was disregarded and the tip of the spring left out a moment's pressure with a sponge stopped all bleeding. The entire procedure has been carried out without completely soiling one sponge. As a rule 3 or 4 sponges were used but the bleeding is no more than that caused by the incision in the thoracic wall.

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# TRANSPLANTATION OF THE GLUTEUS MAXIMUS FOR PARALYZED GLUTEUS MEDIUS<sup>1</sup>

By DAVID R. TELSON, M.D., NEW YORK.

TO paraphrase Lovett the disability resulting from paralysis of the gluteus medius is a perpetual lesson in humility. The limp resulting from this paralysis is most unsightly and one that no brace is in the least able to correct. The patient with gluteus medius paralysis thrusts the foot on the afflicted side forward and realizes that as soon as the opposite foot has left the ground the paralyzed gluteus medius unable to act as a guy rope on the afflicted side will allow a shift of the torso toward the normal side. He therefore makes efforts to prevent this; he uses the trunk muscles to shift the lateral center of gravity to the afflicted side and lurches throwing the entire torso to the paralyzed side. By this maneuver he is able to lift the normal foot from the ground and still maintain his balance.

The gluteus medius and minimus are the only effective abductors of the thigh. The medius is also the principal internal rotator of the lower extremity accomplishing this through its anterior fibers. The patient with gluteus medius paralysis will therefore walk with an external rotation of the limb in addition to the lateral limp.

There have been several operative procedures devised to overcome this very disabling deformity. Lange uses a series of silk cords to connect the origin of the vastus externus to the crest of the ilium. The connecting cords spread out in fan shape from the muscle below the trochanter and passing subcutaneously are attached to the crest of the ilium. Legg transfers the insertion of the tensor fascia lata to the posterior aspect of the shaft of the femur by suturing the fascia lata tendon superiosteally to the femur, or 3 inches below the trochanter. Dickson also uses the tensor fascia lata by transferring its origin from the anterior superior spine to the vicinity of the posterior superior spine.

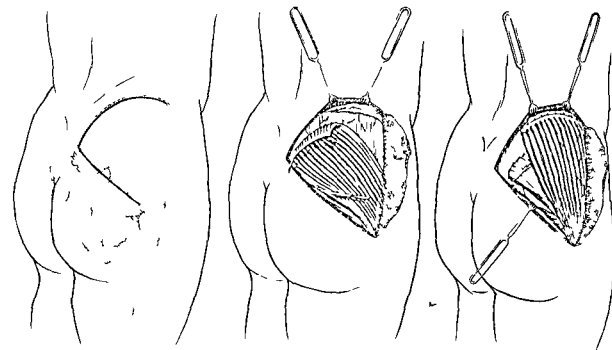
In the Dickson operation it is of great advantage to have only a weakened and not a totally paralyzed medius and in the first two methods gluteus maximus paralysis should be a contraindication. Lovett says that in his group of cases in which the Lange operation was used some were improved but in no case was the limp obviated. Legg states that of 25 cases operated upon by his own method in 3 the limp was entirely done away with and in 8 others the gait was improved.

Lange has devised an operation for gluteus maximus and medius paralysis which consists in mobilizing the lower end of the erector spinæ and by means of long silken strands transferring its pull to the greater and lesser trochanters. Mayer has modified this using a long powerful tube of fascia which envelops the lower end of the erector spinæ and is implanted into the posterior aspect of the femur for maximus paralysis and into the greater trochanter for medius paralysis. Ober, working independently, has used a smaller strip of fascia which is sewed into the fibers of the mobilized lower end of the erector spinæ.

In testing the gluteus medius paralysis one must be particularly careful of involuntary substitutionary movements. A child has two methods of attempting to mislead. When placed directly on the unaffected side and ordered to lift the affected limb the child either flexes the thigh and externally rotates thus bringing the hip flexors into the lateral plane or else internally rotates the thigh and turns the part forward thus bringing the anterior fibers of the gluteus maximus into the lateral plane. These two substitutions are impossible in walking. The first cannot be utilized inasmuch as the hip are extended when the shift from one foot to another is attempted and the second method cannot be brought into play for the medius is the chief internal rotator of the lower extremity and with its paralysis the limb rotates outwardly and throws the gluteus maximus directly posteriorly and out of the lateral plane.

From the observation of this second method of substitution it is readily seen that if the lateral half of the gluteus maximus origin is transferred into the lateral plane we will accomplish surgically what the child has always been attempting to do functionally.

An incision is made from a point over the prominent tubercle on the crest of the ilium about 1 inch in back of the anterior superior spine describing an arc 1 inch proximal to the crest of the ilium and ending posteriorly at a point over the great sciatic notch. The incision is then carried diagonally across the buttock in direction of the fibers of the maximus to a point just above the great trochanter. The skin and subcutaneous fat are reflected back exposing the



I 6  
 I b l l k b c s t t l t b l n t l  
 t f t h l m d f l l t h t t t l l w l d  
 t t h i t c t h I t t h t d t h d t  
 f t h l l r s i t h g l t s m m m s c l t t h b t  
 t l t  
 I T l p t f t h g l t m m l a g

I 7  
 f l g l t d t l b r a h f t h e p  
 f l u t l s l l f g l t l r v  
 F b 3 T l f t l p o t n f t h g l t m m  
 u b t l y d t f d t t h c e s t f  
 t h l m f f l s t l t l c l e h s p t r t  
 t l c t p o p

fascia covering the gluteus maximus and a heavy pal-  
 fat over the fascia covering the paralysed  
 gluteus medius. This fat is dissected out and an  
 incision is made through the fascia investing the  
 gluteus medius just anterior to the fibers of the  
 gluteus maximus and parallel to it. The hand is  
 then passed deep to this fascia underneath the  
 gluteus maximus and the loose connective tissue  
 separated. The entire fascial origin of the  
 gluteus maximus is then secured just above the  
 crest of the ilium some of the fascia covering the  
 erector spinae being taken with it. The great  
 sciatic notch can now be defined by the palpating  
 finger and at its extreme lower border that is  
 below the piriformis muscle the heavy fibers of  
 the gluteus maximus are bluntly separated divid-  
 ing the gluteus maximus into approximately one  
 portion with fascial origin and the intact portion  
 arising from the sacrum sacrotuberous liga-  
 ment and the coccyx. When the fascia on the  
 deep surface of the maximus is reached in the  
 dissection one must be certain that the lower  
 border of the piriformis has been reached. Since  
 success depends upon this all important step of  
 the operation we are doubly cautious continuing

the separation from above downward at the  
 posterior edge of the transplant till the inferior  
 gluteal nerve is brought to view.

The inferior gluteal nerve emerges from below  
 the piriformis muscle and divides into two portions passing  
 laterally to and the other portion of the muscle has in  
 its root and the other portion of the muscle

The superior gluteal vessels will not present  
 any difficulties as they are embedded in a column  
 of fat and are well protected. The lateral portion  
 of the maximus is then swung anteriorly and its  
 fascia is sewed into the crest of the ilium and a  
 portion of the flare of the ilium from which the  
 paralyzed gluteus medius has been stripped.

The fracture line in the arc of transplantation  
 is the length of the branch of the inferior gluteal  
 nerve. This will be found to be ample to allow  
 implantation of the maximus as far forward as  
 the tubercle on the crest of the ilium precisely  
 in the lateral plane. This procedure is carried  
 out with the limb in abduction. A plaster of  
 Paris spica is applied and the extremity kept in  
 moderate abduction for 3 weeks at the end of  
 which time voluntary exercises are begun.

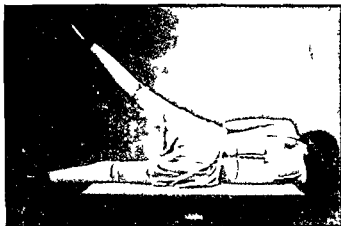


FIG. 4. Abduction of the left hip after transplantation of the left gluteus maximus

The gluteus maximus according to Morris arises from distinct anlagen in the embryo and its separation in the adult does not entail great difficulty. I feel that the operation is mechanically sound in view of the fact that the mass of muscle transplanted is greater than that of the original gluteus medius. This I think is a great advantage over using a comparatively small muscle like the tensor fascia lata. Secondly the line of pull is a straight one and the leverage is much more advantageous than that of the original gluteus medius as its origin is much higher than that of the paralyzed muscle. The portion of the gluteus medius having fascial origin has also fascial insertion into the fascia lata and its line is directed along the outer aspect of the limb with an extremely effective leverage. Re-education in the use of the transplanted muscle is very simple inasmuch as the child has been attempting to use the maximus as an abductor ever since it was paralyzed. The principles of muscle transplantation are all complied with in the above paragraphs and in addition we have transplanted the fascia covering the muscle *en masse* with the muscle so that the possibility of adhesions forming are negligible.



FIG. 5. Demonstrating negative Trendelenburg sign after transplantation of the left gluteus maximus

The child shown in the illustrations operated on in Mayer's section of Fred Albee's service at the Post Graduate Hospital is able to abduct the extremity with power equal to that on the other side. The lateral sway of the body and the Trendelenburg sign have entirely disappeared. The operation of course can be used only in a carefully selected group of cases in which a powerful gluteus maximus is present. However the same selection must be used in the Legg and Lange operations. It is entirely feasible to combine the Dickson operation of transplantation of the origin of the tensor fascia lata with the transplantation of the maximus.

Acknowledgment is made of the kind help of Leo Mayer in perfecting the technique of this operation.



## ZINC-CALCIN DRESSING IN THE TREATMENT AND ANTITHELMINTIC OF FRACTURES

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Of all medical problems the treatment of fracture is the one most frequently encountered with mechanical method and for this reason the mechanistic viewpoint of fracture treatment is apt to be overemphasized. Treatment however demands not only considerable knowledge of all types of splints and bandages, but thorough mechanical training and a complete understanding of the complicated mechanical conditions present but also delicate states of consideration of the manual dexterity. The very best dressing is worthless if it is incorrectly applied either because of carelessness on the part of the practitioner or because the technique is too complicated for general use. There is a vast degree of difference between bandaging in a hospital where all the modern facilities are at hand and bandaging under emergency conditions without the aid of trained assistants and the best equipment. Considerable dexterity is necessary to bandage a patient quickly and with the necessary care. An ill-timed dressing does its duty fully and at all and thereby causes the patient unnecessary pain. However experience has taught that it is almost never advisable to ever apply a dressing hence one must make every effort to have the initial treatment as perfect as possible.

It must be remembered in the use of a new method for the first time that no matter how accurate and detailed the description of the technique may be nothing can overcome the handicap of unfamiliarity with a technique but repeated practice. A novice employing a technique for the first time is possibly lacking the dexterity of the experienced physician who has all the details at his finger tip. Furthermore small mistakes during the initial attempt to follow a new technique may not only lead to failure at that instance but may also lead to the abandonment of a really valuable method.

Because of the fact that a number of courses given at the Vienna Accident Hospital for the American Medical Association have shown that the advantages of the zinc gelatin dressing in the treatment of fracture are unknown to many American physicians. I wish to describe here the use for and the technique of this dressing.

The zinc gelatin dressing is a semi-elastic dressing consisting of 2 to 4 layers of a loosely

woven cotton bandage the meshes of which are filled in by the thick fluid of zinc gelatin. This dressing was first introduced by Unna for the treatment of lacerations and it proved very valuable in such cases as it not only does not irritate the skin but may cure open ulcers and eczemas. Furthermore the bandage also sticks well to the skin and prevents the occurrence of edema. The dressing is extremely practical for the treatment of fractures in that it is irritating, court plaster. The constitution of zinc gelatin is as follows:

Zinc oxide puriss	100.0
Calcium chloride	100.0
Alumina purissima	300.0
Chlorine	400.0

It is advisable to use only the very best materials in the preparation of the mixture since otherwise the glue is not absolutely reliable.

### PREPARATION OF THE MIXTURE

The zinc oxide mixed with just enough water to make a thick paste. After this paste has been completely mixed and stirred it is mixed with the glue. The gelatin which has been softened in cold water must be freed of as much water as possible by squeezing with both hands. The gelatin then contains just 3 parts of water to one more water need be added. It is then put on the water bath and stirred constantly. It becomes fluid in 5 or 10 minutes. Then the zinc-oxide glycerin mixture is added and after a few minutes stirring the glue is ready for use. It is advisable to prepare a large quantity at one time pour it into a shallow dish and cut the elastic mass into smaller pieces. Then whenever some of the mixture is needed a few pieces are put on the water bath and warmed up without adding water until they become fluid and are ready for use. It is not necessary to add an infectant or preservative.

Organic bandages 10 and 15 centimeters in width should be used. This material because of its broader meshes absorb the thick glue much more readily than ordinary bandage material. A 10 centimeter broad flat hair (not bristle) brush is used to paint the mixture on the skin and bandage. In order to keep the zinc gelatin fluid during the process of painting it on the bandage the pot of glue should be kept in a



Fig. 1. Push zinc gelatin cut in piece broad and narrow bands.

pan of hot water. Two pound of zinc gelatin are sufficient for dressing of the lower leg.

#### GENERAL TECHNIQUE

A few pieces of zinc gelatin are put on the water bath to warm. As soon as the glue fluid it is brushed over the *unsharpened* skin and the bandage laid on in spiral under light tension. The edges of the bandage must not cut into the skin in case of disturbance of circulation would thus arise. For the same reason no folds are made in the bandage. Instead the bandage is cut when ever it does not fit well, and is begun anew from that point. After the first layer of bandage has been put on a new layer of glue is brushed on and then another layer of bandage is put on in precisely the same manner as the first until 3 layers of bandage and 4 layers of glue have been put on.

The last layer of zinc gelatin will dry in 30 minutes, and after that it will not soil clothing or linen. If one is in a hurry the last layer of glue can be covered with a layer of cellulose or treated with a solution of 6 parts of formalin in 94 parts of alcohol. The dressing remains on for 3 or 4 weeks until it has either become soiled or loose. It can then be replaced by a fresh dressing if necessary. The bandage is removed by cutting it up the anterior side and then jerking it off suddenly so that the pain due to the pulling out of hair is reduced to a minimum. In patients who perspire freely the bandage soon becomes loosened. In order to keep it tight it can be treated with the solution of formalin in alcohol.

#### AN EXTENSION DRESSING IN FEMORAL FRACTURES

The general treatment of fractures of the femur cannot be considered here. Succinctly such fractures are treated by extension dressing on a Braun splint. The extension is made directly on the bone by means of a Steinmann peg which is driven through the tuberosity of the tibia. This peg is removed in about 3 weeks and replaced by a zinc gelatin extension dressing.

The following technique is used. The glue is brushed on the thigh, the hip, and circularly



Fig. 2. Calico bandage, b Gauze bandage, c Orfanidi bandage.

around the abdomen, and then a layer of organdie bandage is laid on. A second layer of glue is put on next and is followed by a layer of calico bandage 10 centimeter wide which is put only on the lateral side of the thighs from the inguinal region to the middle of the femur. Glue is spread on top of this. The end of the longitudinal calico strips are turned in to prevent later slipping and are fastened by circular layer of bandage. The dressing is finished in the usual way with the bandage forming a regulation piece in a thigh-to-belly direction. The longitudinal strip of calico should not be fixated except above the femoral condyles, as they would otherwise cause disturbing pressure upon the latter. The dressing is allowed to dry for a day while the extension weight is still acting upon the Steinmann peg. The following day the two longitudinal strips are connected by a V shaped wire stirrup and the weight transferred from the peg to the thigh.

After the peg has been removed the lower leg and the knee are covered with zinc gelatin, a layer of bandage is placed over that, then as on the previous day a medial and a lateral longitudinal layer of calico is laid from the knee down to about 30 centimeter beyond the sole of the foot. Then the dressing is finished just as on the thigh, totalizing 4 layers of zinc gelatin and 3 layers of bandage. The ends of the thigh bandage and the dressing of the lower leg must cover each other very well as otherwise each disturbing so-called interstitial edema would occur. The soft parts at such a point are edematous and protrude from between the bandage so that ulcers may occur at the penetrating edge. The longitudinal strips on the lower leg must not be fixated down to the malleoli but must be free of the skin from there down as ankle pain would otherwise occur. The dressing is completed as follows: the ankle and the foot are painted with glue. Then a strip of calico is stretched from the heel over the sole of the foot to about 30 centimeter beyond the toes and a similar strip from the joint of the foot over the dorsal side to the same distance beyond the toe. The usual alternate layers of zinc gelatin and